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“Emerging IT Risks: insights from German Banking”, Geneva Papers on Risk and Insurance - Issues and Practice (in press, 2018).

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Abstract

How do German banks manage the emerging risks from IT innovations, e.g. cyber risk? With a focus on process, roles and responsibilities, field data from ten banks participating in the 2014 ECB stress test were collected by interviewing IT managers, risk managers and external experts. Current procedures for handling emerging risks in German banks were identified from the interviews and analysed, guided by the extant literature.

A clear gap was found between Enterprise Risk Management (ERM) as a general approach to risks threatening firms' objectives, and ERM's neglect of emerging risks, e.g. those associated with IT innovations. The findings suggest that ERM should be extended towards the collection and sharing of knowledge to allow an initial understanding and description of emerging risks, as opposed to the traditional ERM approach involving estimates of impact and probability. For example, as cyber risks emerge from an IT innovation, the focus may need to switch towards reducing uncertainty by knowledge acquisition. Since single managers seldom possess all relevant knowledge of an IT innovation, various stakeholders may need to be involved, exploiting their expert knowledge.

1. Introduction

Cyber risks are on the increase – especially as a result of IT innovation, a key driver of business progress in most industries that inevitably brings significant emerging risks as well as potentially profitable opportunities (Ali *et al.*, 2014; Bhargava, 2014; COSO, 2017; Roland Berger, 2015). Although not entirely new, the pace and impact of IT innovation and its implications have accelerated recently (Price and Adams, 2015), with emerging cyber risks as a major concern.

Many industries, which were until recently relatively stable and safe, now face disruptive IT innovations, e.g. the taxi industry (Uber) and hotel accommodation (Airbnb). Similarly banking has been disrupted by: new payment services (e.g. Google Wallet); peer-to-peer lending; crowd-sourced equity funding and digital currencies (Medcraft, 2015). In the insurance sector, IT innovations include technologies such as big data and telematics on the underwriting side and mobile apps and comparison sites in terms of supply.

IT innovations create significant strategic risks for established organisations, threatening their market share and ultimately their survival. In addition, in their attempts to respond to these strategic risks, often through IT innovations of their own, established organisations can face substantial and often unfamiliar cyber risks: risks which may only emerge once a new innovation has been implemented (Ruan, 2017).

The organisational and risk management literatures have responded only slowly to these innovation-driven opportunities and their associated emerging risks (Aven, 2016; Feduzi and Runde, 2014; Flage and Aven, 2015). This gives rise to several unanswered questions:

Research Question 1 (RQ1): *What suggestions can be offered by enterprise risk management to manage these IT innovation-driven emerging risks?*

Research Question 2 (RQ2): *When is an uncertainty understood to be an emerging risk?*

Research Question 3 (RQ3): *Who should be involved in the management of emerging risks from IT, according to banks and consultants?*

These questions have been largely ignored in both theory and practice (Wilson *et al.*, 2010). In terms of our study, 70% of interviewees had not actively considered emerging IT risks in their risk management. Banks in general adopted a passive stance, waiting to see how things developed, and how other banks responded.

The current academic debate suggests that the management of emerging risks, such as cyber risks, requires an enterprise-wide approach (Anginer *et al.*, 2014; COSO, 2017; RIMS, 2010). Not only because such risks can have a far-reaching effect on the operations and reputations of organisations, but also because of the opportunities which can be gained from

IT innovation. Hence, this is both a strategic and an operational issue and the risk management tool which is currently applied to handle both is typically Enterprise Risk Management (ERM) (COSO, 2017). However, existing risk management, and especially ERM, was not designed to address these emerging risks. As far back as 1992 Kloman pointed to this issue when defining risk management, as "... the art of making alternative choices, an art that properly should be concerned with anticipation of future events rather than reaction to past events" (Kloman, 1992, p.302). Yet, the difficulty with ERM is that it is reactive, and, even to the extent that it looks forward, it relies on incomplete and largely historical knowledge. ERM is largely focused on managing what we know, rather than what we do not know.

This argument is backed up by the current research where interviewees focused on familiar risks and contexts, and all but three of the banks surveyed were lacking a pro-active approach to emerging IT risks. It was also found that, although interviewees recognised the importance of collecting knowledge in order to reduce uncertainty, they did not necessarily understand how to achieve this. One key problem is identifying the range of experts to involve in the knowledge gathering process (risk, IT, HR, etc.), a problem that the literature on ERM has also failed to address.

Our paper first presents a review of the current literature in relation to our three research questions, followed by our chosen methodology for addressing them. This discussion of methodology provides the structure for subsequent sections presenting our findings and conclusions.

2. Literature Review

This review focuses on four key factors which can influence how emerging IT risks are managed using conventional ERM tools. These four factors also form the basis for a subsequent analysis of the research findings:

1. Risk field – emerging risks and respective definitions (Aven, 2012; Jäger, 2009). This is a review of the current literature to facilitate a general understanding of the ongoing debate on emerging risks.
2. Procedures – practices and procedures for the management of emerging risks (Arena *et al.*, 2010). This area is explored in relation to RQ1: *What suggestions can be offered by enterprise risk management to manage these IT innovation-driven emerging risks?*
3. Risk rationalities – how companies convert uncertainties into risks (Emblemsvåg, 2010). The literature is reviewed to provide insights into RQ2: *When is an uncertainty understood to be an emerging risk?*
4. Uncertainty experts – the involvement of employees in an organisation's management of risks (Mikes, 2009). This field of literature relates to RQ3: *Who should be involved in the management of emerging risks from IT according to banks and consultants?*

2.1 Risk field: IT innovation and emerging risks

This section reviews the literature on IT innovations and subsequent emerging risks (RQ1).

The current literature characterises emerging risks, and especially cyber risks, from IT innovations as being complicated, both because they are dynamic (meaning the nature of the risk can change) and because new risks can arise very suddenly (Beasley *et al.*, 2016; Köhler and Som, 2014). The term emerging risk has been shaped primarily by the insurance sector in the last ten years (IAA, 2008; Jäger, 2009; Munich Re, 2016). However, the insurance literature on emerging risks is generally related to the concept of low probability and high consequence (Fischbacher-Smith and Fischbacher-Smith, 2009) and are not exclusively cyber-related (e.g. the effects of global warming). For this reason, emerging risks are of special interest to an insurer, as emerging risk can lead to high-loss claims (IAA, 2008) and potentially to the development of new products. The last five years have shown a gradual trend in other industries towards paying more attention to emerging risks and their frequent connection with IT innovations, recognising that IT innovations present both new opportunities and associated cyber risks (Beasley *et al.*, 2016; Diaz-Rainey *et al.*, 2015; RBS, 2014).

Even though academia agrees on the recently-acknowledged interconnectivity of emerging risks, the analysis of these risks is very limited. Research on IT innovations and their impact on the banking industry has been widely discussed in academia over the last twenty years (Wilson *et al.*, 2010), yet research on IT innovation and its related emerging cyber risks has only recently emerged (Diaz-Rainey *et al.*, 2015; Häckel *et al.*, 2015). Furthermore, from a literature review it can be concluded that no consensus exists on the understanding, or even the mere definition, of emerging risks and the cyber risks associated with IT innovations (Aven, 2016; Flage and Aven, 2015).

2.2 Procedures: ERM in practice

The manner in which professionals work together in the management of uncertainties and risks is highly influenced by the procedures applied in ERM practice (Arena *et al.*, 2010), which are reviewed and summarised in Table 1. Studies of the last 15 years have focused predominantly on (A) organisational factors associated with ERM, (B) defining what ERM is, and (C) the effectiveness of ERM. Table 1 lists these ERM studies in alphabetical order. Each ERM study has been allocated to a research classification and geographical area. In addition, each is specified as a quantitative or qualitative research approach, and the research topic and main findings are summarised.

Author	Research classification and area	Quantitative, qualitative	Research topic	Main findings
Aebi <i>et al.</i> (2012)	(A) Banks in North America during the financial crisis from 2007 to 2008	Quantitative study	Investigate whether ERM related corporate governance mechanisms are related to better performance during financial crisis.	Banks should improve their ERM; embed risk governance by CEO and CRO at the same level; CRO reporting to the board raises performance.
Arena <i>et al.</i> (2010)	(A), (B) Three Italian non-financial firms from 2002 to 2008	Qualitative longitudinal multiple-case study, 41 interviews	Investigate organisational variations in ERM.	ERM is different in all firms due to pre-existing practices; ERM success depends on experts and their power.

Author	Research classification and area	Quantitative, qualitative	Research topic	Main findings
Beasley <i>et al.</i> (2015)	(A), (C) 645 members of the American Institute of Certified Public Accountants	Quantitative descriptive statistics analysis	Explores how boards and management effect ERM adoption and maturity.	ERM maturity is positively related to the involvement of the board and to ERM training for senior management.
Eckles <i>et al.</i> (2014)	(C) 69 firms adopting ERM between 1995–2008	Quantitative desk-top analysis	Tests the hypothesis that ERM reduces firms' cost of reducing risk.	ERM firms have lower stock return volatility; operating profits per unit of risk increase post-ERM adoption.
Farrell and Gallagher (2015)	(C) 225 cross industry firms, which took the RIMS ERM maturity assessment between 2006–2011	Quantitative desk-top analysis	Analyses the valuation implications of ERM maturity.	Firms with a mature ERM have a higher firm value (Tobin's Q premium of 25%); the most important aspects are top-down executive engagement and ERM culture.
Grace <i>et al.</i> (2015)	(C) Insurance companies in the USA	Desk-top analysis	Investigates which aspects of ERM add value.	ERM aspects adding value are economic capital models and risk managers reporting to the CEO.
Halliday (2013)	(A) Executives from the SandP/ASX 200 index in Australia	Mixed method research; Desk-top analysis and survey	Examines organisational structure in risk management.	Board audit committee oversight of ERM. ERM should report to CFO or CRO.
Hoyt and Liebenberg (2011)	(C) 275 publicly-traded insurers in the USA	Quantitative desktop research, data from 1998 to 2005	Measures the extent of ERM and its value implications.	ERM is associated with higher firm value, indicated by a Tobin's Q premium of 20%.
Kmec (2011)	(B) Single case study, energy company	Not further specified	Identifies risk.	Proposes a risk identification method which is a synthesis of existing tools.

Author	Research classification and area	Quantitative, qualitative	Research topic	Main findings
Mikes (2009)	(B) Two financial institutions	Qualitative research, field study with 75 interviews	Classifies ERM types and how they achieve organisational significance.	Suggests two types of ERM models: 1. driven by strong shareholder value, 2. corresponding to risk-based internal control imperative.
Paape and Speklé (2012)	(A), (C) 825 firms headquartered in the Netherlands	Empirical work; secondary data; quantitative	Shows the extent of ERM implementation and the effects on risk management effectiveness.	ERM is influenced by regulations, internal factors, ownership structure, and frequency of risk assessment; no evidence that COSO improves ERM.
Tekathen and Dechow (2013)	(B), (C) One German firm, industry and time range not specified	Qualitative research, singular case site, semi-structured interviews	Explores how ERM and accountability are related.	Implementation of ERM does not ensure organisational risk management ERM does not help to reduce uncertainty.

Table 1: Summary of recent ERM studies

Procedures in this context include a range of risk management processes and tools. One common source of these procedures is the components of the COSO (Committee of Sponsoring Organizations of the Treadway Commission) ERM approach. Although COSO is often criticised for only providing broad guidance, leaving details to the adopting organisations (Hayne and Free, 2014), Paape and Speklé (2012) found that 43% of ERM adopters apply the COSO ERM approach.

However, while the COSO approach is popular, the guidance from COSO and the related academic literature on ERM says very little on how ERM procedures should be used to address emerging IT-related risks. A strongly practice-oriented framework was issued in 2013 by the Information Systems Audit and Control Association (ISACA) and the IT Governance Institute. The “CobiT 5 for Risk” framework is primarily designed for IT and audit practitioners (Babb, 2013). CobiT (Control Objectives for IT and related Technology) aims to inform IT-related strategies and operations and supports legal compliance with regulatory requirements. However, very few academic studies have evaluated the effectiveness of CobiT or investigated where or how it has been adopted (Ridley *et al.*, 2008). Existing research has been published primarily in association with ISACA or the IT Governance Institute, neither of which is considered to be independent (Ridley *et al.*, 2008). In addition,

the “iNTeg-Risk ERMF” (Early Recognition, Monitoring and Integrated Management of Emerging, New Technology related Risks, Emerging Risk Management Framework, funded 2009-13 by the seventh framework programme of the European Union) focuses on the early recognition and management of emerging technology risks, in which technology is not limited to IT. The basis for this is the ISO 31000 and IRGC framework (Jovanovi and Löscher, 2013). To date, this framework has attracted little attention from academics. Hence, the literature review points towards insufficient knowledge of which ERM procedures are critical to the management of emerging risks (Hayne and Free, 2014);

2.3 Risk rationalities

Risk rationalities represent how companies conceptualise uncertainty and risk (Emblemsvåg, 2010) (RQ2). One of the most salient features of innovation is uncertainty (García-Granero *et al.*, 2015), and the connections between innovation, uncertainty, and risk are recurrently discussed in various streams of literature (e.g. Bowers and Khorakian, 2014; Köhler and Som, 2014; Maynard, 2015; Praeg, 2014).

Many academics discuss Knight’s distinction between risk and uncertainty (Gollier *et al.*, 2013; Mikes, 2011; Power, 2009; Zhao *et al.*, 2015), suggesting that “pure” uncertainty implies that no information about possible future circumstances and their probabilities exists, while risk implies at least a partial knowledge of such probabilities (Krane *et al.*, 2014). Moreover, Knight defines risk as the form of incomplete knowledge for which the future can be predicted through the laws of chance (Perminova *et al.*, 2008), including the possibility of expressing future events in probability distributions (Aven, 2010a; Bjerga and Aven, 2015). This view of risk and uncertainty is often reflected in the financial industry literature on risk management. This literature chiefly discusses risks as occurring from an imaginable situation, which implies a particular state of knowledge, while uncertainty infers that there is no unanimity about the state of things (Perminova *et al.*, 2008). Perminova *et al.* (2008) argue that: “Whereas risk concerns itself with the calculation of probabilities based on certain facts, uncertainty concerns itself with epistemology, i.e. are we certain of the facts?” (p.76).

In the academic literature, uncertainty is often reflected in the concept of probability and its assessment (Feduzi and Runde, 2014). Aven (2010b) agrees with this view but warns that the assignment of probability could even lead to camouflaging uncertainties, which could leave important uncertainties unconsidered. Consequently, many scholars have criticised risk managers for not specifically considering pure uncertainty as an important aspect of risk (Aven, 2010a; Bromiley and Rau, 2014; March, 1987). Klüppelberg *et al.* (2014) suggest that further research on uncertainty is warranted to move the attention “... from risk exposure as a basis of decision making to situations where the probability distribution of a random outcome is unknown” (p.402). Uncertainty in relation to emerging risks can be significant and

can affect all risk parameters, such as likelihood and impact. This creates significant risk management challenges and organisations may struggle to collect information to help reduce uncertainty and increase their resilience to respond to the unexpected.

So far, it seems that empirical research on the influence of uncertainty and risk on risk management practice is yet to emerge (Gollier *et al.*, 2013). The concept of uncertainty, and especially the question of when uncertainty turns into a risk, has rarely been mentioned in ERM research (Bromiley and Rau, 2014). This neglect of definitions has been criticised by a number of scholars who point out that the concepts of risk and uncertainty can be of special importance in fresh contexts, e.g. IT innovations, where experience and knowledge about future states and risks are limited (Dombret, 2015; Maynard, 2015).

2.4 Uncertainty experts: organisational roles

Closely linked to the discussion of uncertainty and risk are studies that explore how risk rationalities are dealt with in practice, and which organisational roles are involved (RQ3). Relevant experts are defined as employees of an organisation involved in the management of uncertainties and risks. Based on a typology developed by Mikes (2009), the four roles established in the current academic literature are briefly summarised. First, risk management experts deal with specific risk categories (e.g. credit risks), but the ERM literature hardly mentions which departments require risk managers or the exact responsibilities of a risk manager. Second, senior management is a common focus of the ERM literature. While some academics concentrate on the role of the Chief Risk Officer (CRO) (Mikes, 2009; Paape and Speklé 2012), others focus more broadly on risk oversight and the role of senior management (Beasley *et al.*, 2015). Despite the emerging importance of CROs, Mikes and Kaplan (2015) maintain that the existence of CROs does not guarantee any kind of quality in the risk management process *per se*, probably due to the evolving definition of the exact duties and responsibilities of senior management in ERM (Keith, 2014). Third, the academic literature identifies the professional group of internal auditors as having a central role in the conceptualisation of uncertainty and in how risks are defined and further managed. Fourth, Arena *et al.* (2010) argue that accountants have traditionally played a key role in controlling uncertainty through the analysis of variances in performance.

Thus, it can be concluded that academia and practitioners lack any consensus on the organisational structure and the application of human resources, which best support ERM for emerging risks (Liebenberg and Hoyt, 2003).

3. Data and Methodology

This study explores how emerging risks from IT innovations are managed in the ERM process of twenty-five large German banks covered by the ECB and EBA stress test of 2014 (EBA, 2014). Such large banks are generally more complex and the use of ERM processes tends to increase with complexity (Bessis, 2010). Another advantage of this empirical focus is that the ECB/EBA stress tests are designed to evaluate the resilience of the largest banks to hypothetical shocks, such as an economic downturn (Acharya *et al.*, 2014).

All twenty-five German banks of the focal population (Deutsche Bundesbank, 2014b) were contacted, and in the end eight banks agreed to be surveyed. In addition, two global, systemically important, banks (G-SIB) with representation in Germany were included, to allow rich descriptions of the phenomenon and an understanding of the research issue.

Data on the ten banks was collected *via* semi-structured interviews as they allow direct human interaction and encourage the interviewee to expand and to discuss attitudes as well as facts (Gioia *et al.*, 2013). The research adopted an embedded design that (mainly, see below) included anonymous interviews with the IT and risk manager from each bank, as well as six risk management consultants. Each bank became a separate case, and the risk consultants were treated as an eleventh case. The focus was on cross-case comparisons to allow the investigation of several perspectives and to understand the similarities and differences between the approaches adopted. Furthermore, the findings were compared to the extant literature, with conflicting as well as with consistent viewpoints considered.

Cross-case analysis focused on the banks, but to further the understanding of the ten cases and obtain an independent view, the risk consultants' interpretations were sought to support or challenge the view of the banks and in general to discuss the attitudes of German bank managers towards emerging IT risks. Table 2 lists the ten bank cases, comparisons of their total assets and interview respondents.

Bank	Total assets	Interviews:	
		Risk Manager	IT Manager
A	Large	Yes	Yes
B	Large	Yes	Yes
C	Medium	Yes	Yes
D	Small	Yes	No
E	Medium	Yes	Yes

Bank	Total assets	Interviews:	
		Risk Manager	IT Manager
F	Medium	Yes	Yes
G	Small	Yes	No
H	Large	Yes	Yes
I	Large	Yes	No
J	Large	Yes	Yes

Table 2: Overview of interviewed banks

Bank D had outsourced the entire IT department and did not give approval to interview the IT provider for unspecified reasons. In banks G and I, a second interview was not possible as both banks reported a major risk-related incident, therefore the banks decided not to allow any further interviews at the point of investigation. Nevertheless, as the interviews from banks D, G, and I were comprehensive (though incomplete) and the researcher was allowed to raise additional questions after the initial interview, it was decided to include those banks in the case studies.

4. Findings and Analysis

The analysis of the cases revealed a homogenous picture *within* each bank: IT and risk managers demonstrated solidarity, i.e. they were mostly found to share the firm's declared strategy towards emerging risks, with little discrepancy between them. This corresponds with prior research showing that managers tend to share an organisation's culture, without variation according to functional discipline (Jacks and Palvia, 2014). In contrast, the cross-case analysis revealed wide differences between banks in corporate attitudes towards emerging risks from IT innovations and ERM practices. To capture these important differences, the study developed a classification system for the responses of interviewed managers, presented in the next section.

For brevity, the acronyms RM and IM denote risk management and IT managers, with C for consultants, followed by a letter or number for the respective case, i.e. banks A to J, and consultants 1 to 6. Thus RMA refers to the risk manager of bank A and C-1 to risk consultant (1).

The extant literature has identified IT innovation as a central source of value creation in organisations (Davis and Eisenhardt, 2011), while acknowledging the need for sound risk management. In contrast, however, the interview responses revealed that managers have a wide variety of attitudes toward IT innovations and the treatment of emerging IT risks, ranging from avoidance to an acknowledgement of the need to investigate IT innovations.

In order to capture these risk management approaches and attitudes towards future ERM for emerging risk, a construct termed *emerging risk management concern* was developed. This construct and the assigned capabilities, which were later used to code the data, emerged from the interview responses and from both the academic and practitioner literatures on ERM and emerging risks (Beasley *et al.*, 2015; COSO, 2004; Deutsche Bundesbank, 2014a; FFSA, 2014; IRGC, 2011; Kleffner *et al.*, 2003; Teece, 2012; Wilson *et al.*, 2010). Specific actions adopted and attitudes expressed by managers to promote or discourage risk management for emerging risks were identified. Following Graebner and Eisenhardt (2004), every action and attitude which enhanced the risk management process (e.g. management board oversight of emerging risks, risks also seen as an opportunity (Wu and Olson, 2008)) was coded and counted as +1. On the other hand, the researcher coded as minus 1 every action taken, and attitude expressed, that discouraged risk management, e.g. a lack of "ownership" of emerging risks or uncertainty only seen as being negative. These points were summed to a total score, which enabled the designation of each bank as being proactive, neutral, or discouraging (Graebner and Eisenhardt, 2004) towards risk management for emerging risks from IT innovations.

Bank	Actions and attitudes expressed in the interviews	Points	Category
A	<ul style="list-style-type: none"> ▪ Management lacks knowledge about IT innovations (-) ▪ Lack of “ownership” for emerging risks (-) ▪ Uncertainty seen as a disadvantage (-) ▪ Risk assessment important (+) ▪ Risk management and IT innovation process linked (+) ▪ ERM in place (+) ▪ Risk management focused mainly on the fulfilment of regulatory requirements (-) 	-1	Discouraging
B	<ul style="list-style-type: none"> ▪ Difference between threat and risk (+) ▪ Uncertainty seen as an advantage (+) ▪ Risk oversight by management board (+) ▪ ERM in place (+) ▪ Strategic decision-making allowed by ERM (+) ▪ Risk management and IT innovation process linked (+) 	+6	Proactive
C	<ul style="list-style-type: none"> ▪ ERM in place (+) ▪ Risk management mainly focuses on regulatory requirements (-) ▪ Uncertainty is only seen as negative (-) ▪ ERM must allow strategic decision-making (+) ▪ Lack of “ownership” of emerging risks (-) ▪ Work with other banks to share knowledge (+) 	0	Neutral
D	<ul style="list-style-type: none"> ▪ Uncertainty seen as a disadvantage (-) ▪ “Silo” risk management for emerging risks (-) ▪ Risk oversight by management board (+) ▪ Risk assessment important (+) 	0	Neutral
E	<ul style="list-style-type: none"> ▪ Work with other banks to share knowledge (+) ▪ Uncertainty seen as an advantage (+) ▪ Risk assessment important (+) ▪ Risk oversight by management board (+) ▪ ERM in place (+) ▪ Risk management focused mainly on the fulfilment of regulatory requirements (-) 	+4	Neutral

Bank	Actions and attitudes expressed in the interviews	Points	Category
F	<ul style="list-style-type: none"> ▪ Risk management focused mainly on the fulfilment of regulatory requirements (-) ▪ “Silo” risk management for emerging risks (-) ▪ Lack of “ownership” for emerging risks (-) ▪ Management lacks knowledge about IT innovations (-) 	-4	Discouraging
G	<ul style="list-style-type: none"> ▪ Uncertainty seen as a disadvantage (-) ▪ Risk oversight by management board (+) ▪ “Silo” risk management for emerging risks (-) 	-1	Discouraging
H	<ul style="list-style-type: none"> ▪ Uncertainty seen as an advantage (+) ▪ Risk oversight by management board (+) ▪ ERM in place (+) ▪ ERM must allow strategic decision-making (+) ▪ Risk management and IT innovation process is linked (+) ▪ Continuous activities to increase knowledge about emerging risks (+) 	+6	Proactive
I	<ul style="list-style-type: none"> ▪ Uncertainty seen as an advantage (+) ▪ Risk oversight by management board (+) ▪ ERM in place (+) ▪ ERM must allow strategic decision-making (+) ▪ Risk management and IT innovation process linked (+) ▪ Continuous activities to increase knowledge about emerging risks (+) 	+6	Proactive
J	<ul style="list-style-type: none"> ▪ Risk oversight by management board (+) ▪ ERM in place (+) ▪ Continuous activities to increase knowledge about emerging risks (+) 	+3	Neutral

Table 3: Emerging risk management attitudes of banks' RM and IT managers

The development of the construct *emerging risk management concern* and the assigned capabilities, which mainly emerged from the review of academic and practitioner literatures on ERM and emerging risks (Beasley *et al.*, 2015; COSO, 2004; Deutsche Bundesbank, 2014a; FFSA, 2014; IRGC, 2011; Kleffner *et al.*, 2003; Teece, 2012; Wilson *et al.*, 2010) helped to code the data and to assess if selected actions represented a discouraging, neutral or proactive attitude towards emerging risks. It was observed that managers at proactive

banks had taken steps to promote risk management for emerging risks. For example, the managers of bank I made a formal decision to collaborate with fintech companies to develop and test new IT innovations. The managers of bank B made a similar decision, creating an internal digital lab for designing, testing, and assessing IT innovations and their related risks. Managers at neutral banks had not proactively managed emerging risks so far, but were willing to consider it. As one manager said, "IT becomes more and more important. Data is a production factor" (IM-C). Managers at discouraging banks actively avoided risk management activities for emerging risks. For example, the management of bank D decided to delegate the entire responsibility for outsourced IT innovations and their risks to IT partners.

Table 4 summarises the number of the banks that were summarised as discouraging, neutral or proactive towards ERM for emerging risks, emphasising the heterogeneity of different attitudes across banks (Graebner and Eisenhardt, 2004).

Discouraging	Neutral	Proactive
3 banks	4 banks	3 banks

Table 4: Number of banks per classification category

The following sections present cross-case analysis by contrasting the views of the discouraging, neutral, and proactive banks, and by analysing the views expressed by the risk consultants. It was found that their descriptions of future ERM procedures for emerging risks were very similar to the views shared by the three proactive banks. Therefore, interview quotes from the risk consultants were included mainly to support the views of the managers in proactive banks. Where views deviated, this is explicitly noted.

The structure introduced in the literature review is followed by structuring the findings and analysis in the four areas of interest.

1. Risk field – to discuss how the interviewees in general understand emerging risks.
2. Procedures – to explore RQ1: *What suggestions can be offered by enterprise risk management to manage these IT innovation-driven emerging risks?*
3. Risk rationalities – to provide understanding on RQ2: *When is an uncertainty understood as an emerging risk?*
4. Uncertainty experts – to explore RQ3: *Who should be involved in the management of emerging risks from IT according to banks and consultants?*

4.1 Risk field: findings and analysis

The analysis of the risk field explores the key meanings attached to emerging risks from IT innovations, as expressed in the interviews, which emphasised that German banks attach various meanings to emerging risks from IT innovations. Common opinions as to the characteristics of emerging risks were:

- Emerging risks are characterised by a lack of knowledge
- Emerging risks are characterised by fast developing changes in risk
- Emerging risk are dependent on the underlying IT innovation
- Emerging risks are comprehended as risks with a high uncertainty.

To further discuss the key meanings attached to emerging risks, the following matrix is applied:

Context	New	II) Adapted risk-knowledge	IV) New risk-knowledge
	Familiar	I) Existing knowledge	III) Adapted context-knowledge
		Familiar	New
		Risk	

Figure 1: Emerging risks concepts based on IRGC (2011)

Figure 2 displays the four emerging risk concepts related to knowledge of risk and context. Table 5 shows the frequency of the emerging risk concepts (I, II, III, and IV) occurring in the different cases.

Quadrant	Discouraging			Neutral				Proactive			Consultant					
	A	F	G	C	D	E	J	B	H	J	1	2	3	4	5	6
I)	X	X	X	-	-	-	-	-	-	-	-	-	-	X	-	-

Quadrant	Discouraging			Neutral				Proactive			Consultant					
	A	F	G	C	D	E	J	B	H	J	1	2	3	4	5	6
II)	-	-	-	X	-	X	-	X	X	X	X	X	-	X	-	-
III)	-	-	-	X	X	X	X	X	X	X	-	X	X	X	-	X
IV)	-	-	-	X	-	-	-	X	X	X	X	X	X	X	X	X

Table 5: Emerging risk concepts per case

A familiar risk in a familiar context (quadrant I) was discussed by the discouraging banks and one. This concept was frequently mentioned to describe a situation in which, due to a change in knowledge, it was possible to detect a situation and conceptualise it as a risk.

Two neutral and three proactive banks, as well as three consultants, reported that emerging risks are familiar risks but in a different context (quadrant II). In their view, knowledge about such a risk exists, but it must be adapted to the new context of the IT innovation. Data breach was a frequently mentioned example of this type of emerging risk. Allan *et al.* (2011) support this view: "... when people input incorrect data into a newly established IT system, this operational risk may cause serious problems in other fields, such as financial reporting or reputational risks through poor servicing. The combined symptom can be understood as an emerging risk but in fact it is deeply rooted in existing risks" (Allan *et al.*, 2011, p.189).

The most often identified concept describes emerging risks as a new risk in a familiar context (quadrant III). Across all the banks, this concept was discussed the most. However, none of the informants was able to provide an example of an emerging risk from an IT innovation.

It is striking to note that only one neutral bank, all proactive banks, and all consultants discussed emerging risks as a new risk in a new context (quadrant IV). The other banks did not refer to this category.

In addition, a common refrain from the banks is the relationship between the understanding of emerging risks and decision-making.

"I find knowledge important, but at a certain point, you need to take a decision and you need to go for it. You cannot always wait until you have absolute certainty" (IM-C).

RM-B described emerging risks from IT innovations as strategic risk, and hence saw risk management as an important input to effective decision-making. Fourteen of the interview partners discussed decision-making in the context of emerging risks. C-6 acknowledged:

“The technology is going to enable running the model, not making the decision...” (C-6).

C-4 expressed his concern regarding decision-making and lack of knowledge as:

“Let’s say we have the best process to manage a risk in a process. If people do not understand the underlying technology like artificial intelligence or blockchain, even closer things like APIs [application programming interfaces] or mobile apps, they will end up making the wrong decision. They will object to things, which they do not understand. They will allocate money to projects which are already obsolete” (C-4).

The risk manager of bank C described emerging risks as involving a lack of knowledge and furthermore related this to the corporate culture of a bank:

“Well, the corporate culture sets a certain way of thinking. Especially when new risks arise, I should approach them unbiasedly and eventually not even consider the status quo. And of course it is difficult to do so if I am anchored in the company and its philosophy and culture. A certain distance would be useful when working on this topic. But at the same time this topic cannot be outsourced, because it is a strategic subject and such subjects should stay in the company” (RM-C).

Furthermore, interviewees generally agreed that most emerging risks are already known, but in a different context, and that these risks are already included in the bank’s risk inventory. Ten respondents argued that most of the risks from IT innovation have been present already in other situations (e.g. data breach).

4.2 Procedures: findings and analysis

Interviewees highlighted several ERM components which they deemed as being especially important in the management of emerging risks. Figure 1 summarises these ERM components (adopted from COSO, 2004) and indicates whether at least one interviewee mentioned them.

	Case / ERM components	A	F	G	C	D	E	J	B	H	I	Consult.	Sum
		Discouraging			Neutral				Proactive				
ERM components adapted from COSO (2004)	Establish context strategy	○	○	○	○	○	○	○	●	●	●	●	4
	Identify risks	○	○	○	●	○	○	○	●	●	○	●	4
	Risk assessment	●	○	○	○	●	●	●	○	●	○	●	6
	Risk response	○	○	○	○	○	○	○	●	●	●	●	4
	Communicate	○	○	○	●	○	○	○	●	○	●	●	4
	Monitor and review	●	○	○	●	●	●	○	●	●	●	●	8
	Knowledge creation and sharing	○	●	○	○	●	●	●	●	●	●	●	8
○ Not mentioned ● Mentioned by at least one informant													

Figure 2: ERM components resulting from the interview analysis

Figure 1 shows that the COSO categories of “establishing context”, “identifying risks”, “responding to risks”, and “communicating risks” were not commonly discussed during the interviews. On the other hand, “knowledge harvesting and sharing” and “risk assessment and monitoring” were frequently discussed and hence are further elaborated in the next sections.

Before discussing the findings in detail, it has to be borne in mind that for banks D, G and I no interviews with the IT department were possible, and this represented an obvious omission. Therefore, the likelihood of each ERM component being mentioned was lower than for those banks subjected to two interviews. Furthermore, it should be noted that the column “Consult.” summarises all six interviewed consultants. Hence, the odds are higher that the consultants mention an ERM component, compared to the two interview partners representing a bank.

Knowledge collection (harvesting) and sharing was the most frequently discussed topic, in eight of the ten cases, but the ERM literature is rather silent regarding this activity. However, research on risk management in general emphasises that managing risks is about managing knowledge, and scholars suggest that risks exist independently of human knowledge but that how they are perceived and conceptualised is very much dependent on prior knowledge (Khoo, 2012). The interviewees were frequently concerned about how to acquire knowledge about emerging risks. C-3 summarises his experience as:

“You can never kind of lay back and say: ... I’m 100 percent sure everything is running smoothly.... Because there is always ... something new that could appear ...”
(C-3).

Perminova *et al.* (2008) describe risk management as a means to discover unknown information. Christiansen and Thrane (2014) support this view by describing risk management as a vehicle to transfer information across different levels in an organisation.

Power (2004a) recommends that, when knowledge of a risk is scarce, risk management should act as “an information-gathering process” (p.54).

The consultants each saw a strong need for continuous knowledge harvesting and sharing, and none of the discouraging banks or neutral banks mentioned this. Whereas academic risk research has strongly focused on the examination of risk identification, assessment, response planning, and monitoring (Taylor *et al.*, 2011), knowledge harvesting and sharing has seldom been addressed.

Seventeen managers discussed collaboration with other banks as a means of identifying and understanding more about IT innovations. Furthermore, they reported that outside expertise and participation in IT events are important in assessing new knowledge. Knowledge and expertise come from experience with a wide variety of cues and stimuli (O'Connor *et al.*, 2008). The IRCG (2011) argues that emerging risks have various sources with a possible impact on many organisations; therefore, they strongly suggest collaboration with other organisations to build up knowledge.

With 39 mentions in the case studies, **risk assessment** comprised a second most frequently-raised topic. Respondents said that risk assessment was a prerequisite for triggering further actions, such as the identification of protective actions. Even though seventeen interviewees argued for risk assessment, only seven noted that assigned probabilities do not necessarily reflect the origin and amount of knowledge underlying the risk assessment.

This latter view is also shared by Aven (2012), who argues that probabilities can always be assigned to a risk, but he suggests that probabilities do not show how much valid information underlies the assessment. For emerging risks, RIMS (2010) suggest that the assessment should go beyond quantification and include a qualitative assessment of the risk, in which alternative scenarios for the development of the risks are evaluated.

The topic of risk assessment was discussed by one discouraging bank, three neutral banks, one proactive bank, and the risk consultants. Yet no details were provided for what exactly this ERM procedure should look like.

The third most frequently-raised topic, with fifteen respondents, was **risk monitoring**. Interviewees proposed that more actions were required to monitor the development of a risk and to observe whether defined actions were sufficient, once emerging risks materialised.

“What I think is important as well, and what we are not good at, is to understand and validate measures and to validate whether the defined actions really would help if the risk actually occurs” (RM-F).

In the COSO framework for ERM, risk monitoring is described as a control process that ensures the efficient performance of all the components (COSO, 2004; Moeller, 2007), but interviewees did not share this view. Instead, they perceived risk monitoring as the requirement to oversee the development of emerging risks. Interviewees agreed that there is little guidance on how to monitor emerging risks (Conforti *et al.*, 2013), by vaguely describing the concept and implications of risk monitoring.

A concept discussed by five of the interviewees in relation to risk monitoring was the **risk inventory**. Two neutral banks described it as a portfolio of risks and respective risk description, which helps to identify and classify risks. Two banks (bank C and E) and two consultants found such an inventory to be essential as it helps to set a common language and defines a shared procedure. RM-H shared this view and related risk monitoring to the risk inventory:

“Four, five years ago, we did not know the word cyber risk or system protection. It was not top of our key risks landscape... cyber risk is now officially a key risk. We have a framework for it ... When we have an emerging risk, we assess that risk and then absolutely go do something that we believe is going to be an ongoing consistent ... which is sort of then a monitoring framework and we ... promote it to be part of our framework” (RM-H).

4.3 Risk rationalities: findings and analysis

Effective and efficient risk management requires an appropriate problem framing (Yeo, 1995). This view emphasises the importance of risk conceptualisation.

Nine managers of the banks reported that daily risk management procedures did not address uncertainty. Possible clarifications are provided by Bromiley *et al.* (2014), who found that managers, in contrast to non-managerial employees, tended to have a greater confidence in their decisions and perceived less uncertainty. In addition, March and Shapira (1987) claimed that managers downplay risks because of their self-confidence in influencing the situation. An alternative account could be that the banks perceive uncertainty as an underlying dimension of knowledge and, hence, do not always actively consider it.

Especially in the theoretical academic literature, uncertainty is frequently debated, whereas the practice-oriented ERM literature rarely discusses the concept of uncertainty. Only recently have academics started to relate the concept of uncertainty to their practice-oriented enquiries. For example, Bjerga and Aven (2015) argue that, in a frequently changing risk landscape, uncertainty is a critical factor. However, in their seminal works, Kasperson *et al.* (1988) propose that individuals cannot deal with the full complexity and a multitude of

risks. As a result, simplifying mechanisms (i.e. rules-of-thumb) are used to evaluate risks, thus downplaying uncertainty.

Ten interviewees (1) related the concept of uncertainty to probability frequencies, and nine (2) discussed uncertainty in the light of lacking knowledge and hence not being able to further describe the risk. Interestingly, the discouraging and neutral banks were more concerned with distinction (2), whereas the proactive banks reported that they first have to understand and gain knowledge about an emerging risk before they can quantify it (distinction 1). In the academic literature, both concepts are described as having an impact on risk management practice (Perminova *et al.*, 2008; Renn *et al.*, 2011).

Seventeen informants related the concept of uncertainty to (2) a lack of knowledge about emerging risks. Furthermore, how IT innovation and risks may develop in the future was uncertain for many informants, and RM-J expressed this concern as:

“Yet, we are all aware of it, and we know it can happen to us as well. That is why everybody is so alert. That is the subject of uncertainty, because you have examples from other industries in your mind and you are extremely careful that you do not get yourself into such a situation, which is the first step. And the next step is that we are trying to move to the head of this movement and lead this game” (RM-J).

C-2 discussed whether data about uncertain states existed in order to assess risk, or whether banks actually do not make the effort to identify the data to overcome the uncertainty. He expressed his critical view of banks collecting data and creating knowledge as:

“There is therefore a clear line between uncertainty and ignorance ... Face uncertainty and do not ignore it” (C-2).

RM-B also described IT innovation and the early detection of risks as a means to gain competitive advantage, and C-1, C-2, and C-5 perceived uncertainty as a driver for creativity in finding new solutions to a problem. This view was also shared by C-3 who stated:

“It is almost an advantage as it keeps us on our toes and it ensures that we constantly innovate and that our systems are evolving over time. I would treat it as an advantage” (C-3).

A number of scholars have discussed uncertainty in the context of innovation, mainly with regard to the economic success of the innovation (Häckel *et al.*, 2015). However, in the interviews, the source of uncertainty was not brought up by any of the interviewees.

Academia has frequently related the concept of uncertainty to a system view, in which uncertainty is seen as a result of complex systems where knowledge is lacking about the

variables and their interactions within a system. For example, White (1995) has argued that, when risk management fails, it is usually attributable to a failure to detect emergent risks arising out of the system. In these cases, risk management malfunctions in terms of recognising risks and underestimating their interaction in the system. Blockley (2013) adds to this view, suggesting that the more we understand about a system, the more likely false assumptions can be detected.

None of the interviewed banks raised this topic, though a possible explanation may lie in a lack of resources. A recurring theme among the banks emphasised the severe pressure to ensure smooth and reliable operations and to comply with current rules and regulations. These two objectives could take up all of the banks' resources and not allow for any further activities in relation to IT innovations. However, this was a frequently discussed concept with the consultants. They recommended that emerging risk experts needed to adapt a system view in order to understand the location and reason behind the emergence of a risk.

“Enterprise-wide means that it must be an enterprise-wide system, as a look outside of the bank is therefore very important. And that means I must increasingly look into the risks of my business partners and customers, and the more I understand the risks, the sooner I see when something arises which may affect me” (C-2).

Wu and Olson (2008) have proposed an interesting perspective by classifying ERM as a framework that allows the structured management of uncertainty in a sense that every risk, with its underlying uncertainty, can present an opportunity for the firm. Fifteen experts perceived emerging risks as a threat, but twelve also saw opportunities in emerging risks. It may be significant that only the proactive banks and the risk management consultants see emerging risks as pure chance. This could link to their interpretation of IT innovations as a source of competitive advantage. Eight informants also saw an opportunity in uncertainty as it can generate competitive advantage if managed properly.

“Uncertainty is not a disadvantage. If uncertainty did not exist, then you would not need risk management. Uncertainty is the raison d'être of risk management” (RM-J).

Emphasising the importance of risk communication to include various experts within the organisation to facilitate further risk management procedures (IRCG, 2011), the next section considers who should be involved in the ERM process.

4.4 Uncertainty experts: findings and analysis

ERM is a human resource-based process. Mikes and Kaplan (2015) argue that the effectiveness of risk management depends on the people who organise and contribute to risk

management processes, and in the interviews, C-4 stressed the importance of having the right people in place:

“Oh yes, it is fundamentally all about the people. It is actually not about the IT or the industry. How fast paced the industry is has a role. But it is all about the skill set, the mind-set and the culture of the people... and the culture of the organisation. That is far more important than anything else” (C-4).

C-2 sketched the skills of the experts thus:

“You have to understand the world as an interconnected system, but within their team those experts also must take the role of a specialist. They must be able to link their area of expertise with other issues; they must be able to anticipate the future” (C-2).

Banks B and F also relied on experts from outside their organisation to collect knowledge on emerging risks. RM-B found outside knowledge to be important since a corporate culture automatically influenced how risks are perceived and treated; therefore, he appreciated an outside view *“to think outside the box”* (RM-B).

Interviewees mentioned fifteen different organisational roles (Table 6), which could be involved in the ERM of emerging risks from IT innovations. Furthermore, the discouraging and neutral banks reported that the group compositions were static, whereas the proactive banks and the risk consultants revealed that the composition of the group depended on the respective risk.

Proposed organisational roles to be involved	Informant
Board of directors	C-5; IM-B; IM-F; RM-F; IM-H; RM-H; RM-I;
Business department	C-1; C-2; C-3; C-5; RM-E; IM-F; RM-F; RM-I
Business process owner	C-1; C-5; RM-F; RM-H; IM-G;
Chief Executive Officer	C-5; C-6; IM-B; RM-B; IM-H; RM-H; RM-I; RM-J
Chief Risk Officer	C-2; C-3; C-6; RM-B; RM-J
Digital Officer	RM-B
Group Security	IM-A; RM-A; RM-J, IM-J
IT expert	C-1; C-2; C-3; RM-E; RM-D; IM-G; IM-H
IT risk manager	C-1; C-3; RM-F; IM-E
Legal department	C-5; RM-D

Proposed organisational roles to be involved	Informant
Marketing department	C-3; RM-H
Operational risk manager	C-3; IM-B; IM-C; RM-A; RM-C; RM-E
Project manager	C-3; IM-A; IM-B; IM-E; IM-F; IM-J; RM-A; RM-D; RM-F
Purchasing department	IM-F
“Three Line of Defence”	IM-A; RM-A; RM-J

Table 6. Organisational roles to be involved in the risk management process

Hitherto, based on the interview data, it was not possible to identify who should be involved in terms of professional roles and the management of emerging risks. On the one hand, this was surprising, as bank risk management is usually described as a formal, well-established process with static involvement of resources (BCBS, 2014). On the other hand, it can point to the possibility that ERM for emerging risks is a very new, evolving process for which roles have not yet been established.

It is interesting, however, that interviewees also described the characteristics of the resources needed. In particular, interviewees from proactive banks (and consultants) frequently highlighted the skills and mind-set of the required people. They demanded staff who were very eager to learn new things, were well-connected within the organisation, and were able to share their knowledge to allow decision-makers to make an informed judgement.

Interviewees from banks D and F complained that collaboration between various actors could be improved, but various reasons were mentioned for this lack of cooperation. First, uncertainty experts do not work together because of a lack of time (banks C, D, F). Second, actors have no incentive to work together (banks D, F). Third, the involved experts lack the skills and procedures to work together (bank D). This view was also shared by C-4 who suggested:

“I think enough people are already involved, yet some people need to be upskilled; not increasing the number of people but upskilling people is required. Leadership needs to make a real effort.”

Another frequently mentioned topic was the debate about who has the required knowledge. This is in line with findings by Perminova *et al.* (2008), who report that managers view risk management as a procedure to assemble previously unknown information as well as a means to share knowledge.

The proactive banks reported that they rely on outside expertise, also working with fintech companies, to explore IT innovations. Furthermore, bank H emphasised that the group that handles uncertainty and risk depends on the individual situation and individual knowledge. Bank H described a flexible process, in which experts work together to solve a problem and then return to their individual teams. The proactive banks shared the view that the required knowledge determined who should be involved in the ERM process, not necessarily the occupational role. This view was supported by the IRCG (2011), which proposes that ERM for emerging risks is within the responsibility of everyone in an organisation. Yet the IRCG concedes: "... but having the responsibility is not the same as having skills to exercise that responsibility" (IRCG, 2011).

Moreover, in the interviews the importance of including senior management in the ERM process was stressed. Bank H described the overall responsibility of senior management as setting boundaries in which the employees can work independently and ensure accountability:

"When they feel they can break the rules and get away with it, are they going to be held accountable? So accountability has had a big impact on us ..." (IM-H).

These findings are supported by previous studies in which senior management played a crucial role in successful ERM (Beasley *et al.*, 2015; Subramaniam *et al.*, 2015). Dombret (2015) maintains that it is the responsibility of top management to understand the risks associated with IT innovations, crucial for the success of the business.

The banks that reported IT innovations to be a key driver for success related emerging risks to strategic decisions and therefore pointed to the CEO as the ultimate person responsible (banks B, H, I, J). Banks who classified emerging risks from IT innovations as a regular operational risk, identified responsibility to be more within the middle management or the project manager (banks A, C). Banks E and F reported that senior management had delegated risk management activities to project managers. Bank H commented that IT risk managers in their organisation are increasingly seen as advisory partners to the management. In their recent study, Hall *et al.* (2015) also acknowledge an important relationship between risk managers and executives.

5. Discussion and Conclusions

Academic publications on IT innovations and their associated emerging and risks are numerous, but, despite having enterprise-wide implications, they have been largely ignored within the field of ERM. Aven (2016) has called for new risk management approaches to support the management of these risks and suggests that this is a major current challenge. The present study has provided first insights on ERM for emerging risks, drawing attention to a neglected phenomenon which has been acknowledged to have a significant impact on a number of industries (Medcraft, 2015). The results from this study provide a useful step towards a more nuanced view of how ERM can support the management of emerging risks from IT innovations with a focus on processes, roles and responsibilities, rather than considering the design of actual strategies.

The development of a classification scheme for the banks allowed the clustering into discouraging, neutral, and proactive banks. Seven of the ten interviewed banks were classified as neutral or discouraging and did not take concrete actions to confront future emerging IT innovation risks. Only one German bank and the two globally systemically important banks (G-SIBs) were identified as actively managing emerging risks from IT innovations and hence classified as proactive. Consistent patterns emerged from the interviews with the proactive banks and the risk consultants. While some perceptions about ERM for emerging risks were specific to certain respondents, some commonalities prevailed.

The identification of four dimensions with relevance to emerging risk formed the basis for a literature review and the subsequent analysis of findings. From this we identify four significant findings:

First, a shared understanding of the concept of emerging risks across the banks and consultants does not exist (RQ2). This is in accordance with the few academic publications on emerging risks. Flage and Aven (2015), who classify emerging risks as a relative concept, agree with this view.

Second, discouraging banks conceptualise emerging risks uniformly, whereas proactive banks and risk consultants characterise emerging risks as diverse. Academia agrees that how risk experts understand risks strongly influence the practices and procedures applied to the management of risks (Arena *et al.*, 2010). Proactive banks were identified as using multiple procedures to manage diverse emerging risks, whereas the neutral and discouraging banks did not apply so many processes (RQ1).

Third, even though a common understanding of emerging risks does not exist, a recurring theme in the interviews was knowledge, and knowledge is a common feature of all four quadrants in Figure 2. Furthermore, six interviewees emphasised that decision-makers lack

knowledge about IT innovations and emerging risks; indeed, some IT innovations are not implemented due to a high degree of uncertainty. This discussion draws on the work of Power (2004b), who relates the concept of uncertainty to the management of knowledge, arguing that quantitative risk management is appropriate where large data sets are available and the organisation and managers have a common understanding of a risk. In cases where knowledge is scarce, risk management has to take another role, e.g. knowledge creation and gathering (Power, 2004b; Rodriguez and Edwards, 2014) (RQ1 and RQ2).

Fourth, academic ERM research has been rather silent on knowledge creation and gathering, leaving it to the individual organisation to assign stakeholders to the task (IRCG, 2011). The respondents supported this view and listed a number of managers in organisational roles who should participate. They argued that the choice of experts to be involved should depend on the risk and the required knowledge. Seldom does one single person have all the knowledge about an IT innovation. Hence, various stakeholders should be involved, depending on their expert, specialist knowledge (RQ3).

In relation to concrete conclusions regarding risk management for emerging IT risks it is suggested that:

- The threats from unpredictable emerging risks require the consideration of future scenarios rather than the analysis of past risks.
- The threats from multi-faceted risks from IT innovations means that they can no longer be handled by one specialist department, but arguably need to be addressed at a multi-departmental enterprise (or even an industrial) level.
- All except three banks surveyed reported no proactive consideration of emerging risks from IT innovations. The proactive anticipation of future risks should be treated as an opportunity to raise the profits of financial institutions rather than as post-event responses to cyber-attacks, for example (Rosati et al., 2017).

It is argued that the financial industry in particular is threatened by emerging risks from IT innovations as they can have an impact on market confidence, jeopardize the integrity of data, and present a threat to financial stability in general (Rosati et al., 2017). Nevertheless, IT innovations are essential for the survival of most companies in the financial industry and therefore cannot be avoided. As one interviewee concluded:

“We know it is out there, yet we do not know the implications and how to take care of it” (RM-B).

Blockchain, big data, crowdfunding, etc., are all IT-based innovations affecting banks, but are a mere glimpse of what IT innovations will bring in the future. Overall, this study suggests that the interpretation of ERM in German banks is still backward-looking, lacking the

proactive strategies needed for the management of emerging risks. The question remains open whether discouraging and neutral banks have the time to wait until unseen, but known, risks arrive.

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Appendix 1: Interview guide

The appendix includes the semi-structured interview guide to provide a better understanding of the data from the interviews.

General question: What key meanings are currently attached to emerging risks from IT innovations within the German banking sector?

- 1.1 How would you define emerging risks from IT innovations?
 - 1.1.1 Does your organisation have a common definition?
- 1.2 Can you give me an example of an emerging risk from IT innovation that your organisation is currently facing?

General question: How does uncertainty influence the ERM of emerging risks from IT innovations?

- 2.1 What roles does uncertainty play in the management of emerging risks from IT innovations?
 - 2.1.1 Do you have an example where uncertainty had an impact on the management of emerging risks from IT innovations?
- 2.2 Do you see uncertainty as an advantage or disadvantage in the management of emerging risks from IT innovations?
 - 2.2.1 Can you please elaborate why you see it as an advantage/disadvantage?

General question: Who should be involved in the ERM of emerging risks from IT innovations?

- 3.1 Who in your organisation is involved in the management of emerging risks from IT innovations?
- 3.2 Is this a static group of people or can the people involved vary?
 - 3.2.1 If the groups vary, what factors cause variations?
 - 3.2.2 Should further people/departments be involved in the management of emerging risks?
 - 3.2.3 Who has the overall responsibility for the management of emerging risks?

General question: Which ERM components are critical to the ERM of emerging risks from IT innovations?

- 4.1 Does your organisation manage emerging risks from IT innovations?
 - 4.1.1 If it is managed, can you please explain in detail how?
- 4.2 Does your organisation manage emerging risks per department or throughout the entire organisation?
- 4.3 Which risk management aspects and components do you find especially important in the management of emerging risks?
 - 4.3.1 Why do you find them important?

4.3.2 Is your view shared among your organisation members?