Exploring through uncertainty: the effect of digital and collaborative capabilities

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Abstract

Throughout the years, digital technologies significantly changed knowledge management for innovation, as well as communication systems for successful collaboration, both of which contribute to the ability of organizations to operate under uncertainty. Accordingly, in this thesis, I empirically investigate the influence of digital and collaborative capabilities of an organization on its resilience. More specifically, I discuss resilience in the light of exploration, focusing on the development of adaptive and innovative capabilities to thrive in crisis by leveraging opportunities toward strategic renewal. I tested my hypotheses using OLS and FLM regression models with data collected on Fortune 500 companies. The dependent variable, exploration vs exploitation orientation, was acquired through textual content analysis based on Uotila et al (2009). I find a positive influence of digital capabilities on both exploration and collaboration extent, which also has a positive effect of collaborative networks on relative exploration. Findings indicate that external knowledge acquisition through partnerships could lead to enhanced innovation processes and both cultural and structural improvements within the organisation, generating both resources (knowledge base, human and financial sources) and capabilities (anticipation, adaptation and preparation) for resilience. Furthermore, I conducted an exploratory analysis to factor in the exposure to risk due to opening up the organisation's boundaries to partners. In our dynamic and rather unpredictable environment, it is crucial that managers pay increased attention to the development of resilience capabilities and systems, especially in large corporations like those in Fortune 500, that play a pivotal role in society's resilience.

Keywords*: digital technologies, collaboration, resilience, strategic renewal, exploration*

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Abstract in Portuguese

Ao longo dos anos, as tecnologias digitais alteraram significativamente a gestão do conhecimento para a inovação, bem como os sistemas de comunicação para uma colaboração bem-sucedida, contribuindo ambos para a capacidade das organizações operarem em condições de incerteza. Assim, nesta tese, investigo empiricamente a influência das capacidades digitais e colaborativas de uma organização na sua resiliência. Mais especificamente, discuto a resiliência à luz da exploração, centrando-me no desenvolvimento de capacidades adaptativas e inovadoras para prosperar em situações de crise, aproveitando as oportunidades para a renovação estratégica. Testei as minhas hipóteses utilizando modelos de regressão OLS e FLM com dados recolhidos em empresas da Fortune 500. Verifico uma influência positiva das capacidades digitais tanto na exploração como na colaboração, o que também tem um efeito positivo das redes de colaboração na exploração relativa. Os resultados indicam que a aquisição de conhecimentos externos através de parcerias pode conduzir a processos de inovação reforçados e a melhorias culturais e estruturais na organização, gerando recursos (base de conhecimentos, fontes humanas e financeiras) e capacidades (antecipação, adaptação e preparação) para a resiliência. Além disso, efectuei uma análise exploratória para ter em conta a exposição ao risco devido à abertura das fronteiras da organização aos parceiros. No nosso ambiente dinâmico e bastante imprevisível, é crucial que os gestores prestem mais atenção ao desenvolvimento de capacidades e sistemas de resiliência, especialmente em grandes empresas como as da Fortune 500, que desempenham um papel fundamental na resiliência da sociedade.

***Palavras-chave**: tecnologias digitais, colaboração, resiliência, renovação estratégica, exploração*

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1. Introduction

1.1 Innovation, collaboration and resilience in the digital era

Digital technologies are indispensable in today's business environment. Technology is advancing rapidly and capabilities such as agility, innovativeness and digital skills are crucial for organisations to gain and sustain competitiveness (Powell et al, 1997; Ashrafi et al, 2019). They have enhanced many business processes such as digital marketplaces, customer relationship systems, analytical decision-making and data-driven risk management. Furthermore, they have revolutionised communication systems, facilitating collaborations with any stakeholder. The changing customer demand towards customization, digitalization and sustainability has required enterprises to become more embedded with external sources and partners. By this, they gain access to economies of scale, expertise knowledge, technology and faster and enhanced innovation processes (Laursen and Salter, 2006; Nielsen, 1988).

Besides this, the prevalence of external shocks in recent years has made companies painfully aware of their vulnerability in the dynamic business environment. As a result, managers had to shift their attention from financial performance management towards resilience and sustainable development, which can be described as the process of positive adjustment and functioning prior to, during and following an external shock (Williams et al, 2017). In the face of change and adaptation, the extension and absorption of knowledge is essential, it is a driver of competitiveness and can be seen as an antecedent of strategic resilience (Cohen and Levinthal, 1990; Duchek, 2020). Resilience and competitiveness are linked, in such a way that it focuses on the company's ability to leverage its strengths and express strong leadership. For this, some of the necessary capabilities are awareness and management of vulnerabilities (Lee et al, 2013). In that regard, innovation and exploration play an essential role in the creation of a resilient firm, both as a proactive strategy and a resilience capability (Granig and Hiltgarner, 2020; Teixeira and Werther, 2013). Reinmoeller and van Baardwijk (2005) argue for a combination of internal and external innovation strategies to achieve resilience. These strategies seem to reinforce each other, as collaborative innovation advances internal collaboration and innovation practices (Howard, 2016). Likewise, having an

innovative or explorative culture in place enhances the quality of collaborative efforts in this context (Wang et al, 2015). External knowledge acquisition could lead to cultural and structural improvements within the organisation when the respective cooperation is of quality, generating both resources (knowledge base, human and financial sources) and capabilities (anticipation and preparation) for resilience (Dieterle and Duchek, 2023).

Given that it is highly challenging to predict any quantifiable returns to investing in resilience, it can be hard for leaders and managers to reallocate resources from profitable projects to initiatives aimed at building resilience (Lee et al, 2013). Therefore, a win-win strategy is essential to alleviate this challenge; resilience needs and can be achieved through investments that additionally benefit other business goals. Investing in partnerships and digital capabilities may enhance the firm's internal capabilities and overall competitiveness, besides increasing resilience (March 1991; Shahadat et al, 2023). Accordingly, a resilient culture can be fostered and companies will be more aware of their resilience-strengths and as a consequence, have a better ability to find opportunities in adversity (Knight and Pretty, 1997).

As such, the purpose of this thesis is to better understand the contribution of digital capabilities and inter-firm collaboration to organisational resilience. Using an OLS regression analysis, I reveal the effect of digital technologies and collaborative networks on resilience, which is operationalised as the exploration orientation of an organization. Additionally, exploratory analysis indicated that collaboration may expose an organization to financial risk. For this empirical analysis, I chose a sample of Fortune 500 companies due to their large scale and resource availability, as well as the availability and quality of data.

Resilience is a systems' concept in which especially large firms play a pivotal role in a community's withstanding and recovering through crisis (Berkes & Ross, 2013; McManus et al, 2008). Take the example of the recent Covid-19 crisis, where resilient companies were able to keep their personnel, generate GDP for their country, help other companies out or even reconfigure resources in order to produce mouth masks or disinfectant. Considering the current economic environment, organisational collaboration and digital capabilities have become prevalent, but so did adversities. Although resilience is still a chaotic concept, managers should become increasingly

aware of strenghtening their adaptive capabilities moving forward. Accordingly, understanding a sample of the most wealthy and competitive firms will offer valuable insights on best practices and standards regarding resilience, especially while traditional companies are known to be resistant to change, including digitally transforming or opening up the boundaries to exogenous players. The improvement of individual organisations' resilience will provide a more robust community in general.

2. Theoretical discussion

2.1 Organisational resilience

2.1.1 Resilience as a concept

Naturally, in this uncertain world, the importance of resilience is ever-growing as can be inferred from the broad attention organisational resilience receives from multiple academic disciplines. In management research, there are several streams of resilience to be distinguished, such as crisis management, firm adaptability, reducing supply chain vulnerabilities, preventative practices, performance optimization, etc. (Linnenluecke, 2017). Resilience can be conceptualised as a capability (Duchek, 2019) or as a (process to a) desired outcome (Pal et al, 2013). Moreover, a crisis can be described as an event that suddenly disrupts an organisation, or as a process, typically evolving from a series of events (Williams et al, 2017). The latter allows a company to uncover a strategy to effectively and continuously generate resilience capabilities, including the monitoring, assessment and adaptation of resilience strategies and management. Related constructs or capabilities like flexibility and agility are as important to an organisation's survival but deal with common, daily challenges rather than unexpected adversities and adaptation (Lengnick-Hall et al, 2011). An organisation's ability to adapt has taken a prominent role in defining resilience, as it is argued to be more than what the engineering perspective suggests (Woods, 2006; Lee et al, 2013).

The literature offers several organizing frameworks to help us establish an approach to resilience. Duchek (2019) decomposes process-based resilience into 3 successive stages (anticipation, coping and adaptation) and relates each with necessary organizational capabilities, both proactive and reactive, in order to classify a resilient firm. Mithani (2020) looks at 5 resilience modes (avoidance, absorption, elasticity, learning, and rejuvenation) in context to the nature of external threats. He argues that dynamic resilience, which is more suited for recurring threats, seems to be more manageable in our current environment than static resilience, which applies more to one-time adversities (Mithani, 2020). Consequently, resilience and its capabilities are seen as highly complex due to their dynamic, path-dependent nature, but also as a result of their social embeddedness (Gittell et al. 2006; Ortiz-de-Mandojana et al, 2016; Duchek, 2019). Organisational

resilience is interlinked with communities' and systems' resilience, making it an organisation's job to participate in and respond to adversity to favour overall community recovery (McManus et al, 2008; Lee et al, 2013).

Each of these conceptualizations has handled different affairs of being resilient against adversity which resulted in a fragmented and inconsistent landscape. In the context of this thesis, I look at resilience as a process capability with a base in innovation, namely the capability to self-renew over time (Hamel et al, 2003; Reinmoeller and Van Baardwijk, 2005). Moreover, I focus on resilience as a dynamic capability, bringing adaptation, reconfiguration and renewal into the organisation, reliant on its unique resources (Teece et al, 1997).

2.1.2 Exploration as a path to resilience

Although crises are destructive to most firms, they generate opportunities for those that can take advantage of them. In this thesis, I mainly discuss resilience as the essential ability to reconfigure for strategic or innovative renewal from crises, resilience through exploration. During crises, constraints around decision-making are relaxed, which changes what options are feasible or not (Bryson, 1981). An increasing number of managers then tend to turn to explorative activities such as opening up the product scope, exploring new markets, etc., to thrive through adversity and sustain an organisation's competitiveness in the long run (Reymen et al, 2015; Wenzel et al, 2020).

According to Reinmoeller and van Baardwijk (2005), resilient organisations balance four innovation strategies; knowledge management, exploration, cooperation and entrepreneurship in a dynamic way. By exploration, organisations can continuously build (on) learning mechanisms, by which they enlarge absorptive capacity and knowledge for the firm. Continuous knowledge creation is key to a firm's innovation maturity and long-term competitive advantage (Esterhuizen et al, 2012). It is imperative that this knowledge is absorbed and retained effectively within the firm, in other words, absorptive capacity is essential in leveraging knowledge (Cohen and Levinthal, 1990). Explorative efforts are carried out as a search for knowledge, by which firms learn to access, absorb and leverage it into innovative outcomes (Fosfuri et al, 2008). Hence, in adversity, explorative or innovative practices are considered a prerequisite for competitiveness and agility so as to form creative and timely crisis responses (Esterhuizen et al, 2012; Ashrafi et al,

2019). Although resources might be constrained during periods of adversity, innovating is seen as an effective strategy. Especially for long-term crises, it will preserve survival and create opportunities to earn alternative revenue sources from exploration when other revenues are shut off (Wenzel et al, 2020). With this theory I expect that firms with a higher exploration orientation, will be better resistant to adversity and build my thesis on this. They will have better capabilities and resources to adapt and renew, therefore more resilient in uncertain environments.

2.2 Digital Capabilities

By digital capabilities, we understand the "dynamic ability to use digital technologies and to combine and coordinate internal and external technologies, resources, opportunities and capabilities adapting to changes in the digital environment" (Chen et al, 2023). Investing in digital tools like big data analytics, artificial intelligence, internet of things and cloud computing have enabled firms to completely digitalize their business environment in recent years. Nevertheless, organisations also need the skills and capabilities to integrate and exploit these business changers.

Already back in 2000, IT capabilities were presented as the differentiating factor between low- and high-performing organisations (Bharadwaj, 2000). Research shows that digital capabilities enhance performance, flexibility (Shahadat et al, 2023; Heredia et al, 2022) and (open) innovation processes (Chen et al, 2012), in addition, it has enabled faster and increased communication (Barry et al, 2004. Many of these have a central task when exogenous shocks happen (Miklian and Hoelscher, 2022; Ashrafi et al, 2018; Coombs, 2015). The positive effects of IT and digital capabilities on firm performance have thus been assumed and studied by many, however recent research is rather focused on finding the positive relationship from digitalization, that it overlooks the mediators and internal mechanisms that come along (Tan, Pan & Hackney, 2010; Salomon, Talke & Strecker, 2008). Rapid advances in these digital technologies make it complex and, at times, can themselves be seen as an adversity. When handled with the right adaptive capabilities, digital technologies change how organisations excel in general business but also in adversities. Effective integration of these technologies is crucial to survive and develop into a competitive and sustainable enterprise (Jean et al, 2020). As a result, they are an important topic of research when analysing organisational resilience within the digital era.

2.3 Strategic collaboration

To perform well in turbulent business environments, organizations need to remain up-to-date by collecting and integrating information and knowledge from the external environment into their activities and products. One way to achieve this relies on gathering external knowledge through strategic collaborations.

Knowledge exchange is a central concept in strategic collaboration. This translates into numerous benefits for involved firms, such as fostered innovation (Powell et al, 1996) or significant learning effects. Alliances allow firms to deploy exogenous knowledge for the improvement of internal capabilities (March, 1991), but also to enhance an organisation's social capital (Nahapiet et al, 1998). Moreover, inter-firm cooperation has many other motives, such as market seeking, economies of scale, developing new technologies, co-specialization, etc. Especially in technology-intensive industries, pooling resources is beneficial given the large costs and also in supply chains it brings increased performance and resilience (Ang, 2008; Scholten & Schilder, 2015). Strategic collaboration takes many forms according to their goal, think of joint-ventures, supply chain alliances, R&D consortia, etc. For example, by the means of extensive (innovative) collaborative networks, the 4 strategies to resilience of Reinmoeller and van Baardwijk (2005), i.e. knowledge management, exploration, cooperation and entrepreneurship, have a way to be combined. In today's business environment they have become increasingly common. Recent societal developments such as climate crisis bring along shared goals towards the future, resulting in a more dynamic playing field and growing partner networks. Firms have a critical trade-off to make in deploying internal resources against external collaborative opportunities, but well-managed cooperation projects, especially those exchanging innovation knowledge, can be a source of strategic resilience (Aggarwal et al, 2009; Dieterle and Duchek, 2023).

2.4 Hypotheses development

Organisational resilience is essential for an organisation to thrive and survive in adversity and many have studied its determinants (e.g. Parker and Ameen, 2018; Sreenivasan, 2023). Literature has suggested positive effects of digital capabilities on performance (e.g. Ramakrishnan et al, 2012; Heredia et al, 2022) and collaboration seems to be a risky, but effective performance booster when

managed correctly (e.g. Powell et al, 1996; Salomo et al, 2008). However, increased financial performance does not define a resilient organisation, rather is only one indicator of it. Consequently, the purpose of this research is to investigate the relationship between digital capabilities, firm collaboration and resilience in terms of exploration.

2.4.1 The impact of digital capabilities on exploration

I argue that digital capabilities have a positive influence on a firm's resilience, as digital technologies provide mechanisms to stay responsive to opportunities and challenges, like expansions into new markets, as well as to a crisis (Chen et al, 2023).

Digital technologies have not only made it easier to access knowledge but also made it more efficient to manage and integrate knowledge systems into the organisation's processes (Carlucci et al, 2022). This is beneficial given the importance of extracting external information to catch on to new business opportunities in crisis times, but also to innovate and adapt constantly, strengthening the status quo (Bose, 2009; Chae, 2014; Wang & Dass, 2017)**.** For example, business analytics (BA) are proven to enhance firm performance (Ramakrishnan et al, 2012), and they positively impact information quality and innovation capability going forward (Ashrafi et al, 2019). Besides this, BA also enhances a firm's ability to react to opportunities and threats with ease, better known as agility. Business agility plays a mediating role in the relationship between digital capabilities and firm resilience and should therefore be the focus of improvement when developing digital skills (Saputra et al, 2022). As a result of digital technologies, knowledge can be assembled for data-driven decision-making which benefits performance and is crucial for complex decisions in crises (Brynjolfsson, Hitt and Kim, 2011; Demertzis et al, 2021). Overall, digital capabilities act as a catalyst to explore opportunities, providing technology systems and dynamic skills for value creation.

H1. *Organisations with more digital capabilities are more likely to engage in exploration activities in comparison to exploitation activities.*

2.4.2 Collaboration: fostering resilience through partnerships

Butler (2018) argues that resilient firms must enhance their collaboration and cooperation in all directions, that is internally, externally, as well as horizontally and vertically. Especially opening up beyond organisational boundaries will speed up the innovation process and gain a firm novel knowledge, which is imperative in crises (Chesbrough, 2020). With increasing turbulence, an organisation's level of knowledge achieved in a certain period of time is ought to decrease (March, 1991). Therefore, in times of increased turbulence, extending the knowledge base by bringing in external knowledge will be beneficial to outcompete during adversity. In other words, I argue that more collaboration will lead to increased opportunities for exploration and strategic renewal. However, for collaborations to be effective, it is suggested that mostly experimentation within the project, as well as ambidexterity and relationship quality will enhance understanding of each other's competencies. Accordingly, successful cooperation will lead to innovation goal achievement and enhanced resilience (Dieterle and Duchek, 2023; Iborra et al, 2020; Faems et al, 2008). Innovative partnerships naturally seem to be the most effective when it comes to resilience in terms of exploration and renewal. For example, Ciasullo et al (2022) find a positive impact of collaborative innovation on organisational resilience, arguing it as a novel approach to managing uncertainties. The recent COVID-19 crisis has given us many examples of collaborative efforts to thrive in crisis. We saw companies collaborate to convert manufacturing towards scarce products, while other organisations opened up their intellectual property (Chesbrough, 2020). The external knowledge gathered through collaboration is a vital resource for an organisation to be able to explore, reconfigure, and adapt in crisis.

H2. *Organisations that engage more in collaborative practices, will have increased knowledge sources for exploration and therefore have a higher relative exploration.*

2.4.2 Digital capabilities as a facilitator for collaboration

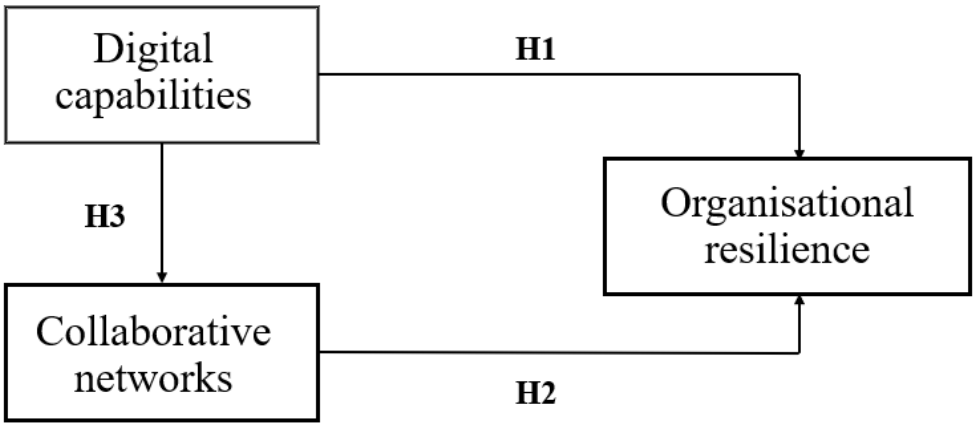
Digital technologies have increased the benefits for collaboration by facilitating the management of these practices through knowledge and information flows (Chen et al, 2012; Eslami et al, 2023). They have transformed both internal business processes as well as inter-firm connections (Bharadwaj et al, 2013).

I expect that organisations with greater digital capabilities will engage in more collaborative practices and thus hold more extensive partnership networks. Digital capabilities have the power to enable strategic collaborations by enhancing the process of sharing, processing and utilizing data, regardless of geographical boundaries. Digital technologies have reduced transaction costs significantly, as a result searching for and negotiating with partners becomes more attractive and the cost of failure is reduced. Firms can exploit the potential of digital technologies in collaborations by being more open to seamless sharing and cultivating a trust and learning environment (Chen et al, 2012). What can make collaborations effective, especially those within the innovation field, is the delivery of data-driven, but also customised and adaptable solutions or business models due to digital technologies (Bleier et al, 2020; Björkdahl, 2020). The value created is bigger than any individual firm could ever achieve due to their pooling of resources, knowledge, and skills (Wang et al, 2015). Following the resource-based view, an organisation equipped with better dynamic (digital) capabilities is better able to attract high-quality partners, exchange better resources and have a higher motivation for an extraordinary outcome (Wernerfelt, 1984). In turn, the firm will also have a greater absorptive capacity to leverage collaboration, as well as more to offer.

Additionally, an increasing number of organisations are producing digital products that bring customer experience onto a new level, such as platform-based business models like Airbnb or Instagram. These types of digital platforms are based on network effects for users, where a larger user base increases the benefit of entering for other users (Belleflamme & Peitz, 2018). Similarly, these platforms can be leveraged for partners. A combination of user bases can significantly increase value for both firms, making collaboration of greater possible value to digital organisations (Katz & Shapiro, 1985). Building upon previous theories, I suggest that digital technologies simplify and enhance the external collaboration process.

H3. *Organisations with more digital capabilities will engage more in collaborative practices*

Figure 1: Theoretical model



3. Methodology

3.1 Data collection

For this thesis, I collected quantitative, cross-sectional data on a sample of Fortune 500 companies in order to analyse their digital, collaborative and resilience efforts covering the year 2023. Given the limited availability of this public and recent data, mostly United States-based companies were used for analysis, resulting in a total of 255 companies to study. I extracted relevant indicators from Crunchbase, Partnerbase and CRSP/Compustat (via WRDS), supplemented with extracted variables and reports from Refinitiv Eikon to conduct content analysis. As a result, an extended dataset was created to answer the proposed research question, namely *how do digital capabilities and collaborative extent influence an organisation's resilience in terms of exploration*?

3.2 Variable measures

Using this unique database, I constructed several variables concerning digital technology, collaboration, and organizational resilience. These are explained next.

3.2.1 Digital measures

Digital capabilities are measured in two different ways. First, the company's active technology stack (*techstack*), or the total number of technology products currently in use by this company. This variable was extracted from Crunchbase and detected by G2 Stack. As a second indicator, I used *IT spend*, assuming that expenditures in information & technology stand in positive relation with digital capabilities. It covers an organisation's commitment to the development of digital technologies by funding its infrastructure. Likewise, this indicator was extracted from Crunchbase.

3.2.2 Strategic collaborations

The extent of a company's collaborative activities is measured in two different ways. First, I conducted a content analysis based on news wires in Refinitiv Eikon. Refinitiv's Thomson Reuters News Monitor is an award-winning app for news analysis and provides an intuitive and efficient source for this type of content research. To obtain the collaboration variable *headline_count*, we

first categorised collaborations based on the pre-defined topic Strategic Combinations, which are defined as "strategic alliances" between two or more companies who have decided to collaborate or share resources in a specific project or more generally the formation of a joint venture where two or more companies are pooling resources to create a separate entity". Accordingly, the headlines within this topic were counted per company, resulting in a measure of collaborative extent for that company. Second, I extracted the number of partners per company from Partnerbase. This platform stores data on B2B partner networks all over the world, including the number of Partners of many firms. I employed the number of partners per company listed on Partnerbase, *partnerbasepartners*.

3.2.3 Exploration vs exploitation orientation by content analysis

I have chosen to study the relative exploration versus exploitation orientation as an indicator of the adaptability and resilience of a company. This concept aims to compare a company's focus on innovative or explorative activities, such as experimentation or innovation by diversified knowledge inputs, to its focus on exploitation or improving the pre-existing, such as operational efficiency or implementation. Both concepts are crucial for sustainability in the long term and to withstand adverse events in dynamic environments (March, 1991).

Many conceptualizations exist to research this concept; such as analysing the extent of search activity (Rosenkopf and Nerkar, 2001; Katila and Ahuja, 2002) or surveying explorative focus (McGrath, 2001). However, I have chosen to assess this relative exploration-exploitation measure by the means of content analysis, as this can be applied in more general contexts. Following Uotila et al's (2009) approach, I used computer-aided text analysis (CATA) which is based on analysing co-occurrences of words in a text, given an overarching theme. In this study, I drew upon two sources of text for each of our companies, i.e. Q4 earnings calls transcripts and Item 1A (risk factors) from 10K annual reports covering the year 2023. I retrieved them through Refinitiv Eikon or via the EDGAR database by SEC. I supplemented the formal 10K reports with earnings calls transcripts as they can be considered a reflection of less "staged" formal corporate communication strategies, indicating a more nuanced version of a company's risk-taking side or motives. For the contextualization of our explorative vs exploitative orientation, I acquired the dictionary based on March (1991) and put forward by Uotila et al (2009). This dictionary has been used in much further

research and ensures reliability, credibility and methodological rigour. Consequently, I used the exploitation-exploration markers that are listed in Table 1, respectively 9 and 8 markers for each construct. Based on these, I took frequency counts and calculated relative exploration orientation scores by means of the following formula:

$$Relative\ exploration_i = \frac{exploration\ count_i}{exploration\ count_i + exploitation\ count_i}$$

That is, by dividing the count of exploration markers by the sum of explorative and exploitative words per company *i* (Uotila et al, 2009), resulting in the variables *relative_exploration_fullt* for the earnings calls transcripts and *relative_exploration_risk* for the 10K risk factors.

Table 1: Dictionaries of exploration and exploitation

Exploration (Uotila et al, 2009)
Explor*, Search*, Variation*, Risk*[1], Experiment*, Play*, Flexib*, Discover*, Innovat*
Exploitation (Uotila et al, 2009)
Exploit*, Refine*, Choice*, Production*, Efficien*, Select*, Implement*, Execut*

3.2.4 Additional and control variables

I included several control variables in our analysis based on prior research of the topic. To account for the fact that larger or older firms tend to have more capabilities to engage in organisational exploration or exploitation (O'Reilly III and Tushman, 2013) and follow diverse strategic orientations (Tushman and Romanelli, 1985), I controlled for company size (measured as a logarithm of the revenue), the geographic extent (by a binomial indicator, domestic or both international and domestic) and age of the company (as the log number of years since founding). All previous indicators were extracted from WRDS/Compustat. In order to account for a company's capabilities and experience regarding innovation, I included the logarithm of all their patents obtained from Crunchbase. In my main and exploratory analysis, I also employ the variable 'GCCR' provided by Refinitiv Eikon, which presents the 1-100 percentile rank of a firm's default probability in the next year, or in other words, the credit risk; a higher score relates to companies that are less likely to go bankrupt or default on their debt obligations in the next year.

[1] For dependent variable relative_exploration_risk, the word risk* was taken out of the exploration dictionary to prevent inflation from 'Risk Factor' page headers and 'risk' titles.

4. Empirical analysis & results

4.1 Overview

In this study, I analyzed a sample of Fortune 500 companies. In Table 2, the (logged) variables' observations, means, standard deviations and quantiles are represented.

Table 2: Descriptive statistics

Variables	N	Mean	s.d.	Q25	Q75
log (Technology stack)	234	3,619	0,606	3,258	3,951
log (IT spend)	156	17,242	4,233	13,165	20,464
log (Partnerbase partners)	170	2,9144	1,512	1,9459	3,5481
log (Headline count)	255	0,5456	0,679	0	0,6931
log (Age)	255	4,140	0,804	3,701	4,762
log (Patents)	197	2,469	1,933	1,004	3,638
log (Revenue)	255	9,983	0,961	9,258	10,474
GCCR in %	254	40,68	28,25	16	64,75
Relative exploration earnings transcript	246	0,7409	0,1018	0,6736	0,8052
Relative exploration risk factors	247	0,2023	0,1543	0,0861	0,2784

The complete Fortune 500 sample consists of 255 companies, with a mean age of 80 years old and an average revenue of almost 40 billion dollars. On average, these companies spend 965 million dollars on information technology, have 80 patents in place and over 100 partners according to Partnerbase. The relative exploration variables are dispersed depending on the analyzed document of content analysis. There are several reasons for this, the first being the purpose of the document. Earnings calls are focused on growth opportunities, strategies and achievements, naturally aligning more with an innovative or explorative theme. Risk factors, in contrast, are inherent to conservative

content and are framed to meet regulatory requirements, with formal content and cautionary language use. Additionally, as mentioned before, risk* was taken out of the exploration dictionary for risk factors to prevent inflation of 'risk' titles and page headers. There is a clear contrast in seeking opportunities on the one side, and mitigating potential risks on the other, which defines the difference shown in Table 2. Furthermore, many of the variables are spending or count variables. Going on with the regression analysis, I have taken the logarithm of these respective variables in order to reduce their skewness for an improved statistical analysis.

Correlation analysis

To get a first view on the relations between our variables of interest, I created a pairwise Pearson correlation matrix. This analysis can be found in Table 3. A positive coefficient means that the respective variables move in the same direction and thus have a positive association. I observe that digital constructs (techstack and itspend) are significantly and positively related with each other ($r(145) = +0.34^{***}$, $p < 0.001$), as well as the collaboration constructs (partnerbasepartners and headline_count) ($r(170) = +0.23^{***}$, $p = 0.003$). This indicates that they are moving in the same direction and offering some more support for the suitability of their use as variable for their construct. Turning to validate the dependent variable, exploration and exploitation are negatively related indicating a trade-off. Instead, I find a positive relationship for both documents ($r(246) = +0{,}239^{***}$, $p<0.001$ for transcripts; $r(247) =+0.327^{***}$, $p<0.001$ for risk factors), indicating more exploration is associated with more exploitation. This is mainly due to the length of the analyzed documents, which I further accounted for in the regressions by adding word_count as a control variable. I do see a positive association between relative exploration for the transcripts and the risk factors ($r(238) = +0.226^{***}$, $p<0.001$), indicating again that the two variables move in the same direction.

Lastly, there is a positive association between GCCR and both relative exploration ($r(246) = +0.253^{***}$, $p<0.001$), and a negative one between GCCR and exploit ($r(246) = -0.177^{***}$, $p = 0.005$). This indicates that more exploration-oriented companies are related with a higher GCCR score, indicating that they are less likely to go bankrupt in the next year. It is important to note that this correlation is not causal, and will be further discussed in the explanatory analysis, yet offers

some support that the financial assessors also expect such companies to be more adversity-proof than their counterparts.

The correlation analysis shows that digital capabilities (techstack and itspend) and the extent of partnerships (partnerbasepartners and headline_count) move in the same direction on a 1% significance level, and both of them are also significantly positively related to relative exploration. As such, techstack and relative exploration_fullt ($r(225) = +0.141^{**}$, $p = 0.34$) and partnerbasepartners and relative exploration_fullt ($r(165) = 0.14^{*}$, $p = 0.073$) are positively related, in line with the hypotheses. Nevertheless, pairwise correlations do not take into account any other variables, hence runs into the risk of omitted variable bias. Next, I conduct a multivariate analysis to test my hypotheses.

Regression models

In order to answer the proposed research question, I analysed the data using 2 models: a Linear Probability Model (LPM) and a Fractional Logit Model (FLM). LPM has the advantage of facilitating the interpretation of the coefficients. My post-fit analysis shows that there are no predictions falling outside of the 0-1 range and homoskedasticity assumption is not rejected a non-significant Breusch-Pagan test for all of the main models, addressing two of the most prevalent issues with LPM. However, when working with fractional, relative dependent variables, a more appropriate model taking this specific nature of the dependent variable would be the Fractional Logit Model. The models are represented in Table 3, with models (1), (2), (4) and (6) being an OLS Linear Probability Model and (3) and (5) being a Fractional Logit Model. For each construct, I gathered data on 2 variables as explained in the methodology section. Going further, I provide the most relevant models in the order of the proposed hypothesis. In the appendices, all different combination models can be found for relative_exploration_risk (Appendix I), as well as for relative_exploration_fullt (Appendix II).

Table 3: Pearson pairwise correlation analysis

Correlations

		techstack	itspend	pat	Revenu	headline_count	partnerbasepartners	GCCR	relative_exploration_fullt	explore_risk	exploit_risk	relative_exploration_risk	exploit_fullt	explore_fullt	age
techstack	Pearson Correlation	--													
	N	234													
itspend	Pearson Correlation	,340**	--												
	Sig. (2-tailed)	<,001													
	N	145	156												
pat	Pearson Correlation	-,024	-,013	--											
	Sig. (2-tailed)	,747	,886												
	N	187	120	197											
Revenu	Pearson Correlation	,229**	,624**	-,020	--										
	Sig. (2-tailed)	<,001	<,001	,775											
	N	234	156	197	255										
headline_count	Pearson Correlation	,381**	,552**	-,004	,339**	--									
	Sig. (2-tailed)	<,001	<,001	,956	<,001										
	N	234	156	197	255	255									
partnerbasepartners	Pearson Correlation	,455**	,316**	-,049	,127	,228**	--								
	Sig. (2-tailed)	<,001	<,001	,566	,098	,003									
	N	157	107	139	170	170	170								
GCCR	Pearson Correlation	,158*	,111	-,049	,089	,096	,048	--							
	Sig. (2-tailed)	,015	,170	,493	,155	,127	,535								
	N	233	156	197	254	254	169	254							
relative_exploration_fullt	Pearson Correlation	,141*	,080	,051	-,004	-,011	,140	,253**	--						
	Sig. (2-tailed)	,034	,327	,485	,955	,865	,073	<,001							
	N	225	151	190	246	246	165	246	246						
explore_risk	Pearson Correlation	,089	,193*	,005	-,004	,109	,094	,094	,080	--					
	Sig. (2-tailed)	,181	,017	,947	,953	,087	,229	,141	,218						
	N	226	153	192	247	247	165	246	238	247					
exploit_risk	Pearson Correlation	-,025	-,052	,024	-,009	,040	,057	-,249**	-,220**	,327**	--				
	Sig. (2-tailed)	,711	,526	,743	,885	,530	,463	<,001	<,001	<,001					
	N	226	153	192	247	247	165	246	238	247	247				
relative_exploration_risk	Pearson Correlation	,100	,256**	,029	,072	,123	,080	,273**	,226**	,659**	-,176**	--			
	Sig. (2-tailed)	,133	,001	,686	,261	,053	,306	<,001	<,001	<,001	,006				
	N	226	153	192	247	247	165	246	238	247	247	247			
exploit_fullt	Pearson Correlation	-,144*	-,053	-,002	-,004	,006	-,134	-,177**	-,756**	-,030	,172**	-,178**	--		
	Sig. (2-tailed)	,030	,519	,974	,952	,926	,085	,005	<,001	,640	,008	,006			
	N	225	151	190	246	246	165	246	246	238	238	238	246		
explore_fullt	Pearson Correlation	,005	,048	,031	-,025	,007	,033	,079	,395**	,066	-,044	,070	,239**	--	
	Sig. (2-tailed)	,943	,556	,670	,700	,914	,674	,216	<,001	,308	,498	,285	<,001		
	N	225	151	190	246	246	165	246	246	238	238	238	246	246	
age	Pearson Correlation	-,091	-,150	-,053	-,085	-,037	-,066	,019	,012	-,155*	-,071	-,113	,095	,113	--
	Sig. (2-tailed)	,167	,062	,457	,174	,558	,389	,763	,847	,015	,265	,076	,139	,078	
	N	234	156	197	255	255	170	254	246	247	247	247	246	246	255

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.2 Effect of digital capabilities and collaboration on exploration

4.2.1 Effects of digital capabilities and collaboration on exploration orientation

As indicated by models (1), (2) and (3) in Table 4, IT spend has a significant, positive impact on relative_exploration_risk on a significance level of 5%. For our OLS LPM, we can interpret this as follows: an increase of 1% in itspend is expected to increase the relative exploration on average by at least 0.007 percentage points, ceteris paribus. Given the average IT spend of 965 million USD, we can say that a 100 million USD increase in IT spending is expected to increase relative exploration on average by about 0.0725 percentage points, ceteris paribus. In case of the FLM, it suggests that 1% additional spending in IT, will lead to an increase of 0.049 in the log-odds of explorative orientation, holding all other variables constant at the mean. These statements validate the first hypothesis, namely that more digital capabilities increase the exploration orientation (and therefore resilience) in a company. However, this is only the case when the dependent variable is based on risk factors. When regressing on relative_exploration_fullt as in (4) and (5), none of the digital indicators seems to have a significant effect, neither does techstack on relative_exploration_risk (see also Appendix I and II). Accordingly, the results require further testing for robustness.

Models (1) and (2) investigate also the effect of collaboration on exploration orientation and find that both 'headline_count' ($p < 0.05$) and 'partnerbasepartners' ($p < 0.05$) have significant effects on the dependent variable relative_exploration_risk. The number of headlines considering a strategic combination for the companies indicates the extent of collaboration a company undertakes. This variable is expected to influence relative exploration in a positive direction, a 1% increase in the count of headlines namely increases relative exploration on average by 0.040 percentage points, ceteris paribus in the LPM model. Furthermore, a 1% increase in the number of partners according to Partnerbase will positively affect exploration orientation by 0.002 percentage points, ceteris paribus. Similarly, I find a positive coefficient in the Fractional logit model, on a 5% significance level. Thereby, H2, suggesting a positive effect of collaboration extent on exploration orientation is also supported. The same analysis on relative exploration based on the earnings calls transcripts, presents a similar positive effect of the extent of Partnerbase partnerships on relative exploration, but a non-significant relationship when it comes to headline_count. This can be found in Model (4) and (5), as well as in Appendix II.

4.2.2 Digital capabilities and collaboration

Lastly, Model (6) tests the third hypothesis, namely the effect of one's digital capabilities on the extent of their collaboration network. As hypothesised, there is a positive and significant effect indicating that when techstack increases by 1%, there is an expected increase in partnerbase by 1.375% holding all other variables constant on a significance level of 1%. Also increased revenue is expected to positively impact the amount of partners on a significance level of 5%.

Table 4: Main regression models

Table 1: Regression Analysis

	Dependent variable:					
	relative_exploration_risk			relative_exploration_fullt		log_partnerbase
	OLS		*glm: quasibinomial link = logit*	*OLS*	*glm: quasibinomial link = logit*	*OLS*
	(1)	(2)	(3)	(4)	(5)	(6)
log_itspend	0.008***	0.007**	0.049**	0.003	0.015	
	(0.003)	(0.003)	(0.021)	(0.002)	(0.011)	
log_headline_count	0.040**					
	(0.019)					
log_partnerbase		0.020**	0.121*	0.021***	0.114***	
		(0.010)	(0.061)	(0.007)	(0.040)	
log_techstack						1.375***
						(0.167)
IBDDomestic	−0.026	0.010	0.076	0.009	0.049	−0.272
	(0.026)	(0.033)	(0.219)	(0.024)	(0.127)	(0.227)
GCCR	0.002***	0.002***	0.011***	0.001***	0.005***	
	(0.0004)	(0.0005)	(0.003)	(0.0003)	(0.002)	
log_age	−0.017	−0.0005	0.002	0.010	0.051	−0.199
	(0.017)	(0.022)	(0.149)	(0.015)	(0.079)	(0.145)
log_revenue	−0.024	−0.029	−0.198	−0.021	−0.108	0.276**
	(0.015)	(0.018)	(0.125)	(0.013)	(0.069)	(0.120)
log_pat	0.009	0.008	0.043	−0.009	−0.048	−0.035
	(0.007)	(0.008)	(0.053)	(0.006)	(0.032)	(0.054)
log_word_count_risk	0.058**	0.030	0.182			
	(0.023)	(0.028)	(0.184)			
log_word_count_fullt				0.062	0.330	
				(0.047)	(0.244)	
Constant	−0.279	−0.065	−2.933	0.206	−1.798	−3.940***
	(0.283)	(0.362)	(2.430)	(0.449)	(2.292)	(1.464)
Observations	119	86	86	85	85	132
R^2	0.333	0.272		0.246		0.457
Adjusted R^2	0.284	0.197		0.167		0.435
Residual Std. Error	0.123	0.121		0.089		1.150
F Statistic	6.862***	3.600***		3.102***		21.169***
Note:						*p<0.1; **p<0.05; ***p<0.01

4.3 Exploratory analysis

4.3.1 The double-edged sword of opening up beyond firm boundaries

Up until now, I have discussed the positive effects of collaboration on exploration, mainly as a result of resource pooling, risk sharing and knowledge transfers. Nevertheless, opening up outside of organisational boundaries also increases vulnerability and exposure towards external shocks and risks, which can even result in a dilution of one's competitive advantage (Mohr et al, 2002). When deeply engaged in collaboration, organisations may become dependent of one another, by which partner's vulnerabilities can become their vulnerabilities. Furthermore, there are also risks inherent to the partnership, such as contractual breach, cultural misfit, knowledge leaks, dominant partners etc. This could result in a dissimilar distribution of the gains and losses of a collaboration. As Dahlander & Gann (2010) state, "Openness can result in resources being made available for others to exploit, with intellectual property being difficult to protect and benefits from innovation difficult to appropriate". The likelihood of unintended knowledge leakages or other risks grows as a firm opens up to such collaborative interactions, especially in early-stage collaborations (Roy & Sivakumar, 2011; Salge et al, 2013). As a result of extensive collaboration, we can thus argue that a firm is more exposed to risk from the external environment. Consequently, being more exposed to these external risks translates into less slack for other high-risk projects, therefore undermining exploration. For this reason, I engage in exploratory analysis to investigate how exposure to risk plays into the positive relationship between collaboration and exploration.

4.3.2 Collaboration and the risk of external exposure: effects on relative exploration

To answer the proposed hypothesis, I used OLS to estimate the effect of exposure within this study. As a measure of a company being subject to exposure, I employed the variable Global Combined Credit Risk (GCCR) which allows an intuitive comparison across firms in their capability to face distress. As such, firms with a higher score and thus a lower default probability, are better positioned to take on the risks coming forth from collaborative practices.

As indicated by Model (1) and (2) in Table 5 and contrary to the expectations, both our collaboration variables have a positive and significant impact on the Global Combined Credit Risk, in this case our indicator for exposure to risk. Namely, a 1% increase in a company's partner network, will on average increase the credit risk by 3.231 on the percentile rank, holding all other

variables constant ($p<0.10$). Likewise, when headlines on strategic combinations increase by 1% for a particular company, its' GCCR is expected to increase on average by 8.066 on a significance level of 5%. These increases are consequential to an extended partnership network and stand equal to a less exposed company, in such a way that it is less likely to default or go bankrupt in the next 1-year period. In other words, companies who engage in more collaborations, will be exposed to less financial risk in terms of our GCCR indicator, in contrast to our expectations. H4 is therefore not supported. Furthermore, the indicator of the internationality of a company also significantly influences exposure. In this case we can argue that domestic firms on average, have a lower credit risk rank, i.e. by 9.835, than firms who are also active on an international level and are thus more likely to default, holding all other variables constant ($p<0.1$). It is important to note that the indicator GCCR has limitations, which will be further discussed in the limitations section.

Next, I looked at the effect of the global combined credit risk on our exploration variables. On both exploration indicators of the earnings calls (Model 3) and the risk factors (Model 4), GCCR is proposed to have a positive and significant effect. One percentage increase in the GCCR rank relates on average with at least 0.001 percentage points increase in relative exploration, holding all other variables constant on a 1% significance level. This positive relation was already shown in our main regression models (1) to (5) in Table 4 as well, with the inclusion of more control variables. This indicates that companies who are less exposed or less likely to go bankrupt, are expected to explore relatively more. Conversely, firms that are highly exposed to risk or bankruptcy, engage less in explorative practices. In general, explorative or innovative practices require a large amount of funds and are characterized by uncertain returns. Therefore, companies that have a high exposure to risk or bankruptcy will not have slack resources to invest in high-risk projects but rather exploit and improve their core processes.

Table 5: Exploratory regression models

	Dependent variable:			
	GCCR		relative_exploration_fullt	relative_exploration_risk
	(1)	(2)	(3)	(4)
log_partnerbase	3.231*			
	(1.730)			
log_headline_count		8.066**		
		(3.269)		
GCCR			0.001***	0.002***
			(0.0002)	(0.0003)
log_age	−2.584	−0.280	−0.007	−0.025*
	(3.426)	(2.773)	(0.009)	(0.013)
IBDDomestic	−9.835*	−8.253*	0.004	−0.040*
	(5.559)	(4.417)	(0.015)	(0.021)
log_revenue	−3.753	−3.144	−0.004	−0.009
	(2.898)	(2.484)	(0.007)	(0.011)
log_pat	0.207	−1.373	−0.0003	0.006
	(1.322)	(1.039)	(0.003)	(0.005)
log_word_count_fullt	1.900		−0.006	
	(13.173)		(0.031)	
log_word_count_risk				0.050**
				(0.019)
Constant	67.769	77.356***	0.840***	−0.134
	(124.171)	(27.361)	(0.294)	(0.228)
Observations	136	197	190	192
R^2	0.063	0.057	0.083	0.223
Adjusted R^2	0.019	0.032	0.053	0.198
Residual Std. Error	27.860	27.703	0.089	0.130
F Statistic	1.441	2.311**	2.775**	8.866***
Note:				*p<0.1; **p<0.05; ***p<0.01

4.3.3 Crisis management systems

To have a last supplementary view on resilience, I looked at the difference between companies that have a crisis management system in place, and those that don't. Specifically, 222 out of 254 firms in our sample report on contingency plans to reduce downtime in disasters. A t-test indicated a statistical difference in these groups for both techstack and itspend on at least a 5% significance level, with all of them displaying higher values in the 1-group. In other words, companies that have a crisis management system in place seem to have more digital capabilities, compared to those who don't have a crisis management system in place. Statistical evidence for these statements can be found in Appendix III, however, it is to be interpreted with care given the limited availability of the data. Nevertheless, the overall picture aligns with the theoretical expectation, lending further support to the importance of digital capabilities for resilience.

5. General Discussion

5.1 Discussion

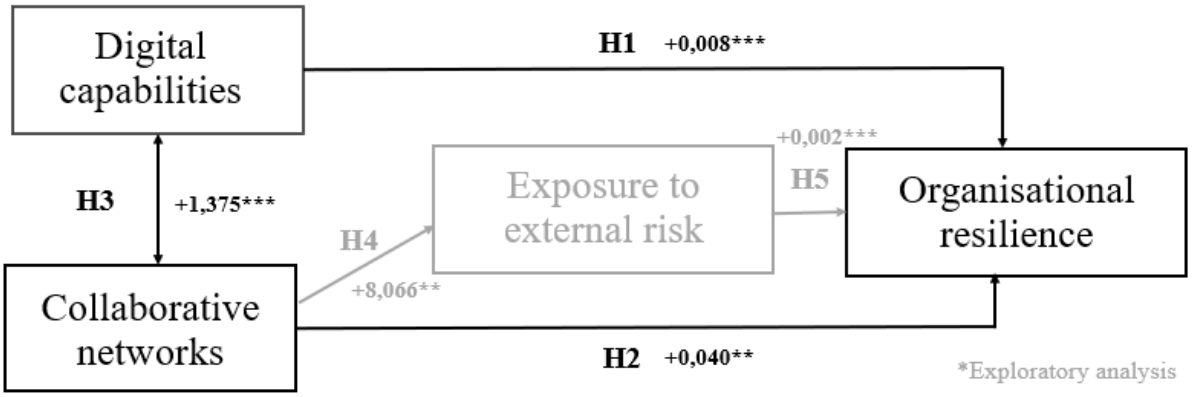
The growing number of crises creates an imperative of resiliency, where adaptability and innovation are key. Given the unquantifiable results of developing resiliency within firms, it can be a hard trade-off to make for managers. Hence, I aim to improve our understanding of how digital and collaborative capabilities are linked to organisational resilience, thus guiding managers to make better-informed decisions. In this dissertation, I linked explorative orientation to resilience arguing it as necessary strategic renewal to thrive and survive in crisis, enhancing learning effects and adaptation capabilities within the firm. Resilience is thereby proxied by how exploration-oriented a firm is, focusing on experimentation and exploring unknown environments rather than improving the status-quo, in order to obtain capabilities to withstand and adapt but mostly to leverage opportunities in crisis. This was supported by the negative association of exploration with financial default risk. I find empirical evidence of a positive effect of both digital capabilities and collaborative extent on our dependent variable, relative exploration. Furthermore, my analysis suggests a positive effect of digital capabilities on collaborative extent.

Digital capabilities, as indicated by IT spend, positively influence exploration orientation as they provide mechanisms to efficiently manage, integrate and leverage knowledge flows (Carlucci et al., 2022). In the context of our sample of large firms, IT infrastructures should already be well-established in today's digital environment. We are therefore rather looking at the extra investments in technologies compared to the rest of the firms. Furthermore, resilience can be fostered through collaborative networks. In times of crisis, a firm's knowledge pool is ought to decrease (March, 1991). By gaining access to external knowledge through partnerships, the pool of opportunities for exploration increases significantly and innovation is sped up as a result of resource pooling and cost efficiencies (Chesbrough, 2020). However, research has shown that a firm's position in the respective interfirm network also influences its innovativeness and therefore also its explorative opportunities (Ahuja, 2000). Given that we are discussing Fortune 500 firms, we expect them to be leaders in the process. As follows, my research suggests a significant positive effect of the extent

of a partner network on an organization's relative exploration. Given the ability of digital technologies to leverage inter-firm communication systems and knowledge flows toward elevated value, I also hypothesised and validated the positive relation between digital capabilities and collaborative networks. Although firms often tend to be resistant towards collaboration due to coordination costs, these are ought to decrease once digital technologies are integrated well. As such, when partners are willing to share their data seamlessly and a great collaborative culture exists, we expect an even higher effect on exploration (Chen et al, 2012). The combination of these dynamic capabilities has the power to lead to data-driven, customised and easily adaptable solutions, resulting in an advantage over competitors (Bleier et al, 2020; Björkdahl, 2020).

I also conducted an exploratory analysis to consider the effect of the exposure to risk due to opening up firm boundaries. First of all, I tested whether engaging in more partnerships will lead to an increased exposure towards risk, in my analysis linked to a lower GCCR (more likely to go bankrupt). Although I expected a negative relationship, I found a positive coefficient, indicating that a larger network of partnerships is associated with the company being less probable to default. This could be explained by the diversification and pooling of risk that comes forth from partnerships. Other reasons could be that larger partner networks signal a strong business or large bargaining power, included in the GCCR score measure. Secondly, given the cross-sectional nature of this study, I expected that an increased exposure to external risk would leave the company with a lower ability to engage in explorative practices, inherently high-risk. Conversely, a company that is less exposed to risk will have a higher exploration orientation. As a result of the OLS regression analysis, I indeed find a positive relationship between GCCR and relative exploration. Therefore, it suggests that a company that is less likely to go bankrupt, and thus less exposed to risk, will engage in more relative exploration. However, Global Combined Credit Rank does not sufficiently resonate with the construct of exposure to risk, but rather focuses on financial risk. It is because of this limitation that I have chosen to separate this analysis from the main analysis to an explorative section. An updated research model with the relations from our analysis can be found in Figure 2.

Figure 2: Updated research model



5.2 Managerial implications

In current practice, it becomes only more relevant for managers to become aware of their dynamic capabilities that benefit resilience. This thesis sheds light on how resilience can be achieved through exploration, as well as how dynamic capabilities such as digital technology competence and partnerships play into this. Given that returns coming forth from investing in resilience are rather indistinct, leaders have a hard time trading off profitable projects to resiliency for the same funds (Lee et al, 2013). Therefore, I reasoned that it is significant to achieve resilience through investments that additionally benefit other business processes, such as investments in partnerships and digital capabilities. Rather than in-crisis solutions, it is important to create resilience and adaptive capabilities proactively. In my analysis, I prove that digital capabilities and collaborative networks are beneficial to this process of creating an explorative orientation. Consequently, this triggers learning mechanisms which will ensure that the company is more flexible and change won't be such a shock internally. More than just surviving, especially resource-wealthy firms like Fortune 500 then have the ability to exploit crises through strategic renewal and innovation. For example, successful innovative collaboration could lead, in combination with seamless digital technology integration, to market-changing and data-driven solutions which are easily reconfigurable in crisis. Nevertheless, it is important for managers to be aware of the risks accompanying such practices. Successful collaboration is inherent to trust dynamics and good governance, in order to reduce asymmetries and knowledge leakages (Faems et al, 2008). Although

engaging in partnerships is a way of sharing risks, it is important to acknowledge that one's exposure to risk is elevated, and partners should act accordingly. Overall, it is advised for managers to incorporate digital technologies into their systems, in such a way that when either internal or external collaboration exists, data and knowledge flows are straightforward and controlled. In conclusion, it is most important to be aware of the respective risks and to manage accordingly, in order to achieve resilience for the organisation.

5.3 Limitations and further research

While attempting to contribute to the literature on resilience, I stumbled upon some limitations. First of all, rather than analysing a cross-sectional dataset, it would have been more insightful to gather longitudinal data so that we could track developments over time and have a better understanding of causality. This would have offered a more dynamic view, which is why we would advise future researchers to engage in multi-year analysis on these relationships. Besides this, although we had a sample of 255 companies, missing values reduced our actual observations to about 85 firms for the main regression analysis in Table 4. A missing values plot is included in Appendix IV, as well as a population test between the dropped and non-dropped variables in Appendix V, indicating there is no statistical difference in the means of the 2 samples for relative exploration. Furthermore, as noted earlier I conducted an exploratory analysis as a consequence of the limited reliability of the GCCR variable explaining 'exposure to risk'. In future research, it would be interesting to look more deeply into this relationship with a better approximation for this construct, for example volatility of cash flows or market share variability. It could be complemented with other indicators to provide a more holistic view on one's risk profile. Even though I looked into resilience in terms of exploration, there are many different conceptualizations of resilience to be researched in connection to digital or collaborative efforts, such as supply chain resilience, social or HR resilience or crisis management systems. Moreover, by looking at the extent of partnerships, I overlook the actual effectiveness of the partnerships in place. Lastly, throughout this research, I have argued for an increased exploration orientation to the benefit of resilience. In practice, many argue for a balance of exploration and exploitation, a concept I could unfortunately not reach accurately with my data. However, it would be most useful to extend this research in the context of balancing exploration and exploitation.

5.4 Conclusion

In sum, my thesis offers support for three relationships that are essential for managers to perform well and remain resilient at turbulent times in the digital era: Digital capabilities positively affect collaborative extent as well as exploration orientation, due to their significant contribution to communication systems and the management of knowledge. Furthermore, firms with a broader partner base tend to engage more in explorative practices, although being relatively more exposed to financial risk. External knowledge acquisition is therefore important when exploring beyond status quo, to bring increased efficiency into the innovative process. The insights of this thesis shed some light on the dynamic capabilities that contribute to resilience in terms of strategic renewal. The management of knowledge, internal and external, is a key resource and should be leveraged for pro-active resilience capabilities, as well as for exploration.

Appendices

Appendix I: All construct combinations on relative exploration from risk factors

	Dependent variable:				
	relative_exploration_risk				
	OLS				*glm: quasibinomial link = logit*
	(1)	(2)	(3)	(4)	(5)
log_itspend	0.008***			0.007**	0.049**
	(0.003)			(0.003)	(0.021)
log_headline_count	0.040**		0.037**		
	(0.019)		(0.016)		
log_techstack		0.020	−0.0001		
		(0.025)	(0.017)		
log_partnerbase		0.006		0.020**	0.121*
		(0.011)		(0.010)	(0.061)
IBDDomestic	−0.026	−0.007	−0.035	0.010	0.076
	(0.026)	(0.027)	(0.022)	(0.033)	(0.219)
GCCR	0.002***	0.002***	0.002***	0.002***	0.011***
	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.003)
log_age	−0.017	−0.006	−0.020	−0.0005	0.002
	(0.017)	(0.018)	(0.014)	(0.022)	(0.149)
log_revenue	−0.024	−0.015	−0.019	−0.029	−0.198
	(0.015)	(0.014)	(0.012)	(0.018)	(0.125)
log_pat	0.009	0.002	0.006	0.008	0.043
	(0.007)	(0.006)	(0.005)	(0.008)	(0.053)
log_word_count_risk	0.058**	0.031	0.049**	0.030	0.182
	(0.023)	(0.027)	(0.020)	(0.028)	(0.184)
Constant	−0.279	−0.084	−0.075	−0.065	−2.933
	(0.283)	(0.310)	(0.236)	(0.362)	(2.430)
Observations	119	129	182	86	86
R^2	0.333	0.199	0.251	0.272	
Adjusted R^2	0.284	0.145	0.216	0.197	
Residual Std. Error	0.123	0.135	0.130	0.121	
F Statistic	6.862***	3.724***	7.246***	3.600***	
Note:					*p<0.1; **p<0.05; ***p<0.01

Appendix II: All construct combinations on relative exploration from earnings calls transcripts

	Dependent variable:				
	relative_exploration_fullt				
	OLS				*glm: quasibinomial link = logit*
	(1)	(2)	(3)	(4)	(5)
log_itspend	0.003			0.003	0.015
	(0.002)			(0.002)	(0.011)
log_headline_count	0.002		−0.008		
	(0.014)		(0.011)		
log_techstack		0.004	0.018		
		(0.017)	(0.011)		
log_partnerbase		0.012		0.021***	0.114***
		(0.007)		(0.007)	(0.040)
IBDDomestic	0.002	0.019	0.007	0.009	0.049
	(0.019)	(0.019)	(0.015)	(0.024)	(0.127)
GCCR	0.001***	0.001***	0.001***	0.001***	0.005***
	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.002)
log_age	−0.001	−0.003	−0.007	0.010	0.051
	(0.012)	(0.012)	(0.009)	(0.015)	(0.079)
log_revenue	−0.010	−0.008	−0.004	−0.021	−0.108
	(0.011)	(0.010)	(0.008)	(0.013)	(0.069)
log_pat	−0.002	−0.001	0.001	−0.009	−0.048
	(0.005)	(0.004)	(0.003)	(0.006)	(0.032)
log_word_count_fullt	0.007	0.056	0.003	0.062	0.330
	(0.036)	(0.044)	(0.032)	(0.047)	(0.244)
Constant	0.687**	0.230	0.680**	0.206	−1.798
	(0.335)	(0.420)	(0.304)	(0.449)	(2.292)
Observations	116	129	180	85	85
R^2	0.163	0.139	0.111	0.246	
Adjusted R^2	0.101	0.081	0.069	0.167	
Residual Std. Error	0.090	0.091	0.088	0.089	
F Statistic	2.612**	2.414**	2.663***	3.102***	
Note:					*p<0.1; **p<0.05; ***p<0.01

Appendix III: T-test difference in crisis management system for itspend and techstack respectively

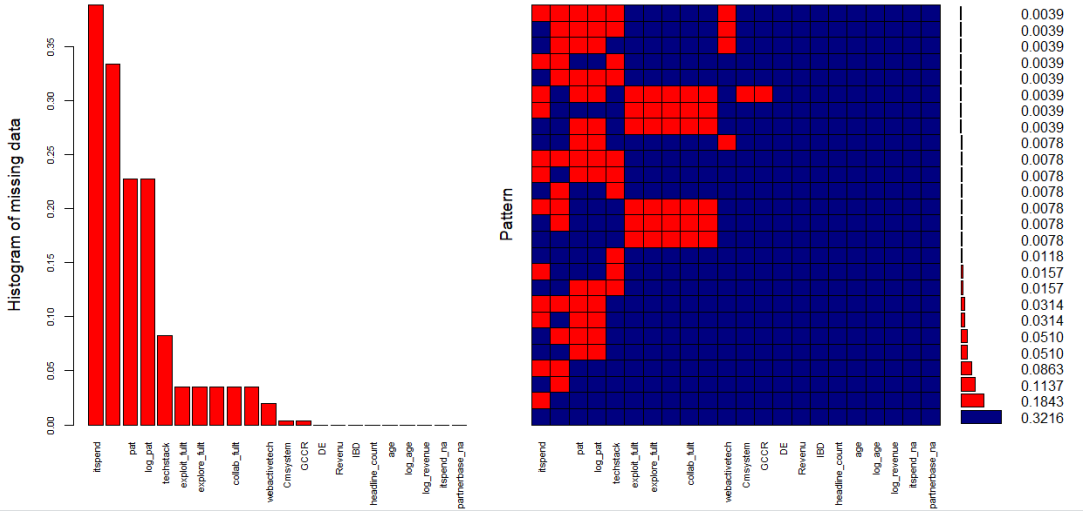
```
        Welch Two Sample t-test

data:  log_itspend by Cmsystem
t = 2.1341, df = 19.07, p-value = 0.04603
alternative hypothesis: true difference in means between group yes and group no is not equal to 0
95 percent confidence interval:
 0.04982761 5.05941966
sample estimates:
mean in group yes  mean in group no
         17.52049          14.96587
```

```
        Welch Two Sample t-test

data:  log_techstack by Cmsystem
t = 2.445, df = 35.481, p-value = 0.01958
alternative hypothesis: true difference in means between group yes and group no is not equal to 0
95 percent confidence interval:
 0.05166371 0.55578020
sample estimates:
mean in group yes  mean in group no
         3.657658          3.353936
```

Appendix IV: Missing values plot



Appendix V: T-test of analyzed and dropped sample

```
        Welch Two Sample t-test

data:  complete_obs and dropped_obs
t = -0.19898, df = 1649.8, p-value = 0.8423
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.593339  1.299834
sample estimates:
mean of x mean of y
 9.122398  9.269150
```

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