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Scientific mapping of 20 years of literature on corporate cash holdings and risk

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Abstract

Aim/purpose – This study aims to synthesize the extant literature and illustrate the thematic evolution and intellectual structure of research on corporate cash holdings (particularly precautionary cash holdings) and risk, through a scientific mapping of works published over the past 20 years.

Design/methodology/approach – The study applies various bibliometric analysis techniques offered by the SciMAT software. Following the PRISMA methodological rigor, the analysis covers 110 research publications indexed in the Scopus database from 2005 to 2025.

Findings – The study reveals motor themes leading the development of this domain: cash holdings, cash flows, investment decisions, working capital management, and bank loans. Emerging topics highlight the importance of agency costs and industry studies, while the notable gap underscores the need to develop a risk management theme. Research on Central European companies and sectors beyond energy, agriculture, finance, and hospitality is scarce. This opens the door to further research on corporate governance, cross-country studies, or industry-related factors.

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Research implications/limitations – This study contributes to the scholarly discourse by highlighting the multifaceted, interconnected dimensions of cash holdings and risk management decisions, thereby enhancing managers' and policymakers' knowledge. Future research may explore the link between cash holdings and new emerging types of risk, namely ESG risk, cybersecurity risk, climate risk, or geopolitical risk. The main limitations of this study stem from the methodological choices, namely: using the Scopus database solely, defining selection criteria and keywords, and setting specific parameters in the SciMAT software.

Originality/value/contribution – This study makes a novel contribution to the literature, being the first to use the SciMAT tool to analyze cash holdings and risk-related studies. It demonstrates that studies linking cash holdings to risk management represent a potentially promising area for future research. This work can serve as a reference point for researchers investigating the determinants of cash holdings, particularly precautionary cash holdings, in the context of risk management. The findings can also guide future strategies to develop more efficient and effective cash and risk management in a turbulent business environment and amid global shocks.

Keywords: Cash holdings, precautionary motive, risk, risk management, bibliometric analysis, scientific mapping, SciMAT.

JEL Classification: G32, G34, D81, M21.

1. Introduction

The liquidity preference theory developed by Keynes (2018) explains motives for holding cash (i.e., maintaining cash as part of liquid assets). These motives include: (1) transaction motive – firms need liquid resources to finance their daily operations, (2) opportunity motive – firms maintain cash holdings to use unexpected investment opportunities, and (3) precautionary motive – firms hold cash reserves to respond to unpredictable cash flow changes and to hedge risk (de Carvalho, 2010; Opler et al., 1999). The precautionary motive of holding liquid reserves is particularly relevant, as it links cash holdings to the risk management issues (Han & Qiu, 2007).

Corporate cash holdings are an important topic in corporate finance research, as confirmed by numerous literature reviews. Over the last twenty years, a significant increase in corporate cash reserves has been observed, which has raised academic interest and managers' attention (Amess et al., 2015). As da Cruz et al. (2019) suggested, cash holdings play a vital role in firms' policies, affecting their liquidity, ability to survive during adverse events, investment policy, dividend payments, efficiency and profitability, as well as level of costs (e.g., transaction costs, agency costs).

In particular, the precautionary motive for cash reserves underscores the risk management function of cash holdings (Han & Qiu, 2007). Excess cash forming an available slack can be used as a risk retention tool (Wieczorek-Kosmala & Błach,

2019). Financial slack, in the form of cash reserves, is purposefully maintained by a firm to provide self-sufficient coverage against the negative outcomes of risk occurrence. Therefore, cash holdings can be used as a buffer to address unexpected events (Cambrea, 2021) or as a way to hedge against adverse shocks (Hay Salem & Hussainey, 2021). It is observed that firms increase cash holdings during times of uncertainty and high inflation, as they raise the likelihood of survival during economic distress (Das et al., 2023), and build firm resilience to external shocks (Cowling et al., 2020; Ferreira & Vilela, 2004). Precautionary cash reserves are used to avoid financial constraints, especially when access to capital markets or bank loans is costly or unavailable (El-Halaby et al., 2021).

The link between cash holdings and risk-related issues has been explored in numerous empirical studies. For example, a study by Tong (2010) found that firms with higher CEO risk incentives hold lower cash reserves, consistent with risk-related agency theory. Similarly, Chen et al. (2020) observed that stronger internal control quality helps optimize a firm's cash level. It is also noted that reputation risk motivates firms to hold cash for precautionary reasons, while higher transparency (as a result of risk disclosure) may reduce information asymmetry and decrease the need for cash reserves (Hasan et al., 2022; Lai et al., 2025).

Recent studies in this field increasingly underscore the importance of cash holdings for risk management in this specific macroeconomic context. Many studies highlight the strategic role of cash holdings during crisis times, such as the global financial crisis (Chang & Yang, 2022; Lian et al., 2014) and the COVID-19 pandemic (Cowling et al., 2020; Tawiah & O'Connor Keefe, 2020). An emerging stream of research explore firm's cash management decisions in the context of geopolitical risk (Lee & Wang, 2021; Cho, 2023), litigation risk (Liu, 2024), cybersecurity risk (Wang et al., 2023), or climate-related risk (Ahmad & Karpuz, 2024; Lee et al., 2023). In particular, climate and geopolitical risks, which predominate in studies linking cash decisions to risk management.

Recently, Khatib et al. (2022) suggested that despite the growing interest among researchers, there are limited systematic reviews on corporate cash holdings. Recent literature reviews on cash holdings and risk-related topics tend to address specific issues rather than providing a comprehensive overview of this domain. For example, Kumar and Symss (2025) used VOSviewer software to examine the determinants of cash holdings during the war in Ukraine. They also discussed cash holdings as a hedge against geopolitical risk. Flores-Macha et al. (2024) analyzed extant literature on financial planning and liquidity risk. Therefore, they discussed cash flow management and financial reserves as measures applied in financial planning. They also emphasized the importance of anticipating situations that may increase the level of liquidity risk.

In turn, the study by Jamali and Elbouazizi (2025) used a narrative literature review (NLR) to evaluate methodological aspects and research gaps in studies on exchange rate risk and cash flows in the MENA region. Therefore, this literature review focuses on a single type of risk and a single region.

Our study complements prior literature reviews by focusing on the relationship between corporate cash holdings and risk-related issues in the context of the precautionary function of cash holdings. According to Haj-Salem and Hussainey (2021), there is limited literature linking the concept of risk, including risk reporting, to cash holdings. In addition, one may observe the growing importance of risk and risk management in public discourse. Therefore, understanding the relationship between corporate cash holdings and risk has become an important field of research for academia and business. Although empirical studies in this field collectively underscore the importance of cash holdings as a risk management tool and a buffer against external shocks, there is still no literature review on the relationship between corporate cash holdings and risk. This observation reinforces the need for further research in this emerging and significant domain.

To address this gap, our paper aims to synthesize the extant literature and the evolution of research on corporate cash holdings from the perspective of risk-related issues, with a particular focus on the precautionary motive for cash holdings. The study employs various bibliographic tools offered by the SciMat software to analyze scientific works indexed in the Scopus database¹. Therefore, this paper falls into the stream of studies on cash holdings and risk relationships.

Our scientific mapping analysis aims at answering the following research questions:

- RQ1:** What is the intellectual development of research on corporate cash holdings and risk-related issues?
- RQ2:** What topics have dominated researchers' enquiries analyzing corporate cash holdings and risk so far?
- RQ3:** What are the emerging themes in research on corporate cash holdings and risk-related issues?
- RQ4:** Are there any notable gaps in the literature on corporate cash holdings and risk-related issues?

The remainder of the paper is structured as follows. Section 2 explains the research methodology, including the applied searching strategy and methods of bibliometric analysis. Section 3 presents the results of the pre-mapping and knowledge mapping analyses, conducted using various bibliometric tools, to answer the formulated research questions. Section 4 discusses significant findings in the context of the current state and future research directions in this field. Section 5 concludes the study with a summary of key findings.

¹ <https://www.scopus.com/pages/home#basic>

2. Research methodology

2.1. Research design

This paper synthesizes the extant literature and traces the evolution of research on corporate cash holdings and risk-related issues, with a particular focus on the precautionary motive of cash holdings. To answer the research questions presented in Section 1, a dataset of scientific publications was obtained and analyzed using various bibliometric tools.

The research process consists of two stages: (1) data collection and selection (preparing the relevant dataset by following the PRISMA procedure), and (2) scientific mapping (pre-mapping and knowledge mapping phases).

This study adopts a different methodological approach than prior literature reviews on cash-holding-related issues. Indeed, it applies the SciMAT software for bibliometric analysis following the methodology explained by Cobo et al. (2012). A similar approach was successfully applied in several literature review studies focusing on various aspects of corporate finance-related topics, e.g., working capital (Mirón Sanguino et al., 2024), corporate governance (Guerrero-Villegas et al., 2024), and risk management (Gorzeń-Mitka & Wieczorek-Kosmala, 2023). Interestingly, no literature review to date has explored corporate cash holdings and risk using this methodology. In this context, our paper introduces a novel approach with great potential to generate interesting results and advance understanding in this area.

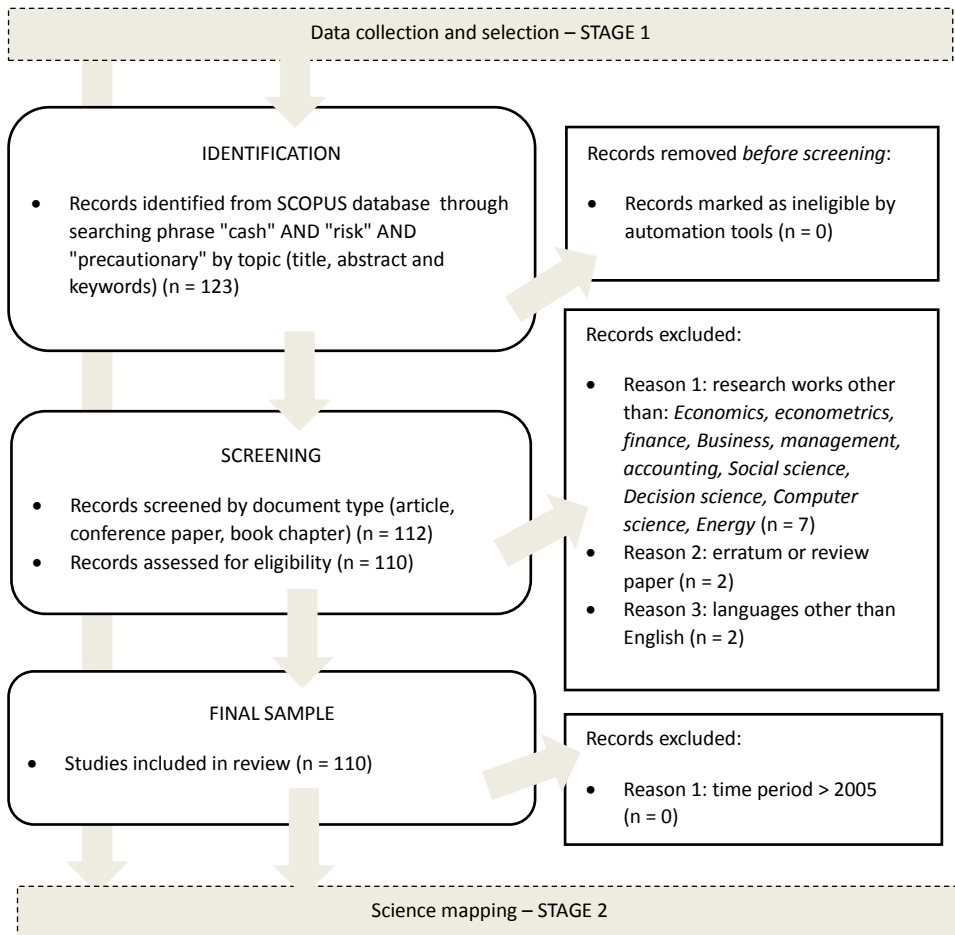
2.2. Data collection and selection

The dataset of bibliographic records for publications on corporate cash holdings and risk was obtained from the Scopus database, which covers high-quality scientific journals.² The selection of papers from the Scopus database follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) procedure (Flores-Macha et al., 2024; Page et al., 2021), as presented in Figure 1. The following search conditions were applied: words CASH and RISK and PRECAUTIONARY in the title, abstract, and keywords of the publications indexed in the Scopus database. All three words were assumed to co-occur. The first paper that met the search criteria and was indexed in the database was published in 2005, which

² The study relied on a single database, as prior research by Harzing and Alakangas (2016) proved that using multiple databases simultaneously does not lead to finding more relevant articles for further analysis.

marks the start of the analysis period. The final year was deliberately set to 2025 in view of the dynamic changes in corporate risk and risk management observed in recent years, as even the first two months of 2025 yielded several studies addressing current issues related to cash holdings and risk.

Figure 1. Literature search on cash holdings and risk – PRISMA flow diagram



Source: Authors' own elaboration.

The initial dataset covers 123 works. Deduplication was unnecessary, as all records were retrieved solely from the Scopus database, which automatically handles internal duplicates. Next, the exclusion criteria were applied. First, the publication should fall into the following research fields: Economics, econometrics, and finance; Business, management, accounting; Social science; Decision science;

Computer science; and Energy. These research fields were selected deliberately because they collectively encompass the theoretical foundations and empirical evidence that help understand cash holdings decisions in a company, governance structures, corporate risk perceptions, and risk modelling from various perspectives. They also cover most of the works meeting the search criteria (N = 116). Next, the publication type was limited to article, conference paper, or book chapter, published in English. This resulted in the dataset consisting of 112 records. After a detailed analysis of all obtained abstracts, two papers were excluded as irrelevant to the chosen research area, as they examined cash holdings in the context of households. Therefore, the final sample yielded 110 records.

The exact search string was defined as follows:

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(TITLE-ABS-KEY (cash) AND TITLE-ABS-KEY (risk) AND TITLE-ABS-KEY (precautionary)) AND (LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI") OR LIMIT-TO (SUBJAREA, "COMP")) OR LIMIT-TO (SUBJAREA, "ENER")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "ch")) AND (LIMIT-TO (LANGUAGE, "English"))
```

2.3. Science mapping

As anticipated in Section 2.1, the scientific mapping process comprises two phases. In the pre-mapping phase, the tools available in the Scopus database were used to conduct a temporal analysis of publications. This resulted in the research productivity and citation analysis over time, illustrating the development of this domain during the last twenty years. In the knowledge mapping phase, the obtained dataset was analyzed by using the SciMAT (Science Mapping Analysis Tool) software (v1.1.04) following the framework presented by Cobo et al. (2012) and Moral-Muñoz et al. (2020).

The key SciMAT settings for this analysis were defined as follows:

1. Unit of analysis: Words (authorRole=true, sourceRole=true, addedRole=true).
2. Kind of network: Co-occurrence.
3. Normalization measure: Equivalence index.
4. Cluster algorithm: Simple centers algorithm:
 - Max cluster size: 10,
 - Min cluster size: 3.

5. Evolution measure: Inclusion index.

6. Overlapping measure: Jaccard index.

In the SciMAT analysis, a threshold value of 1 was applied to include keywords in the co-occurrence network. Additionally, a systematic data-cleaning procedure was conducted prior to analysis (e.g., merging synonyms, removing generic terms, and unifying singulars and plurals).

The longitudinal mapping analysis focuses on identifying a research field's conceptual structure through keyword co-occurrence analysis. The SciMAT uses four types of measures: centrality, density, equivalence, and stability measures (Cobo et al., 2012). Density reflects the internal development and coherence of the research theme, while centrality illustrates its interaction with other themes, highlighting its importance to others. The centrality and density measures enable visualization of the research results through thematic networks and strategy diagrams. Thematic networks are built from co-occurring keywords in scientific publications and include nodes (keywords) and edges (links between nodes) that form clusters. Each cluster is regarded as a theme with internal coherence. The size of the node indicates the frequency of a particular keyword in the dataset, and the thickness of the edges represents the strength of its co-occurrence. Each thematic network corresponds to a research theme in the strategic diagram for a selected analysis period. Depending on the centrality and density measures, each cluster may be classified as:

1. Leading (motor) themes (upper-right quadrant) – core topics of the research domain.
2. Highly developed but isolated themes (upper-left quadrant) – niche or specialized topics.
3. Emerging or declining themes (lower-left quadrant) – new, fading, or peripheral topics, underdeveloped and of low relevance for the research domain.
4. Basic and transversal themes (lower-right quadrant) – central to the field, but not yet well developed, indicating potential research gaps that need to be developed in future studies.

Equivalence index measures the strength of the link between two keywords based on their co-occurrence in the analyzed dataset. Finally, the stability index illustrates the continuity of themes between two consecutive periods. The equivalence and stability measures allow the creation of an overlay diagram and a thematic evolution map. The overlay diagram illustrates the continuity and stability of the research field by showing changes between subsequent periods. The thematic evolution map presents the development of the clusters (leading themes), the elements shared by two consecutive periods, and the new elements of each period. The thematic evolution map analysis addresses research question one (RQ1), illustrating the intellectual development of the research field. In ad-

dition, the strategy diagrams and thematic networks offer valuable insights for answering the research questions related to major themes, underdeveloped (research gaps), and emerging topics in this domain (RQ2-RQ4).

3. Research results

3.1. Intellectual development of research on corporate cash holdings and risk

The detailed analysis of 110 documents retrieved from the Scopus database illustrates the evolution of research on corporate cash holdings and risk over the last twenty years. To answer the first research question (RQ1), both the pre-mapping and science-mapping tools were used.

The pre-mapping analysis uses the temporal distribution of publications and their citation rates (cf. Figure 2, Appendix). The first paper, recorded in the Scopus database and covering these issues, was published in 2005. Until 2015, the number of publications per year was fewer than five. From 2016 to 2020, up to 10 papers were published per year. The dynamic increase began in 2022 and culminated in 2024, with the highest number of papers examining corporate cash holdings and risk: 26 papers met the search criteria.³ A similar trend is observed in the number of citations per year, with a dynamic increase starting in 2020, resulting in the highest number of citations in 2024, at nearly 700. Both datasets confirm the growing interest among researchers in topics related to cash holdings and risk. This may be linked to global challenges and a turbulent business environment during this time, including the COVID-19 pandemic, supply chain disruptions, the Russian invasion of Ukraine, the energy crisis, and high inflation. Risk and risk management issues have become more important during such periods, and cash holdings are often used in their precautionary function.

Four sequential five-year periods were identified for further examination:⁴

1. First period – years: 2005-2009 with six papers. Academic discussion during the period was centered around the Global Financial Crisis, the introduction of corporate governance reforms, and the implementation of tighter reporting standards and risk management guidance.

³ The dataset was retrieved from Scopus on the 1st March, 2025; therefore, the study covers data only for 2 months of 2025. However, six papers have already been published in 2025.

⁴ This approach follows the recommendations by Cobo et al. (2012) to perform analyses using a comparable number of publications in each sub-period or time intervals of similar duration. Given the relatively low number of publications during the first 10 years of analysis, we decided to use the second option.

2. Second period – years: 2010-2014 with 10 papers. This period was characterized by post-crisis credit constraints, the eurozone sovereign-debt crisis, and a slow economic recovery.
3. Third period – years: 2015-2019 with 14 papers. During this period, low interest rates and economic stability were maintained. However, in the academic discourse, new topics appeared, linked to technological disruptions, green finance frameworks, and the rise of the ESG concept and sustainability pressures from regulators and stakeholders.
4. Fourth period – years: 2020-2025 with 83 papers. The current period is characterized by high macroeconomic volatility (the COVID-19 pandemic, energy crisis, high inflation, and rising interest rates) and geopolitical instability (the Russian-Ukrainian war). Global economies must face the consequences of rapid digital transformation, AI-driven risk analytics, climate-related disruptions, cybersecurity threats, growing sustainability regulations, and operational resilience requirements.

The intellectual development of this research domain (RQ1) is also illustrated by the overlapping map (Figure 3, Appendix) and the evolution map (Figure 4, Appendix) provided by SciMAT software as a result of the science mapping stage.

The analysis of the keywords over time, presented in the overlapping map, indicates a partially mature area of research on cash-holdings and risk-related issues, with a steadily growing number of keywords and their persistence over time, from 11 keywords in the first period to 49 in the fourth period of analysis. This suggests the expansion of the research field and thematic richness. The dynamic development is particularly noticeable over the last ten years: 2015-2025. The stable development of this research field is illustrated by the increasing stability index, which reached 53% in the last period (cf. Figure 3, Appendix).

The analysis of the evolution map (Figure 4, Appendix) reveals a strong connection between CASH HOLDINGS (the dominant theme, as indicated by the size of the node in the fourth period) and several themes: INVESTMENT DECISIONS, BANK LOANS, and WORKING CAPITAL MANAGEMENT, indicating the importance of a financial perspective. In the fourth period of analysis, the previously central theme of CASH HOLDINGS (dominant in the third period) evolves into several new, more specialized topics, such as CASH FLOWS, WORKING CAPITAL MANAGEMENT, INDUSTRY STUDIES, and AGENCY COST. Notably, these themes appeared as subthemes in earlier periods and have currently become more influential. This means that research interest becomes focused on specific, narrow topics related to cash holdings and risk.

The RISK MANAGEMENT theme, first recorded as a separate theme in the third period, continues in the fourth period, underscoring its growing importance amid high volatility in the business environment. However, there is a lack of a direct, strong link between CASH HOLDINGS and RISK MANAGEMENT themes, which may indicate the necessity of a new direction for future research linking corporate cash holdings and risk management.

To sum up, the research field on corporate cash holdings and risk-related issues has experienced dynamic development, particularly during the 2020-2025 period. This observation is supported by the increasing number of publications and citations, the growing number of persistent keywords, and the expansion of research themes in both theoretical and empirical studies (from one theme in the first period to six themes in the fourth period). All these bibliometric indicators confirm the intensifying interest of academics and the thematic richness of this field of research.

3.2. Identification of main topics in research on corporate cash holdings and risk

To identify the main research topics on corporate cash holdings and risk-related issues (RQ2), strategic diagrams and thematic clusters were analyzed separately for each period.

The detailed analysis of papers published in the first period (2005-2009) indicated only one leading theme – CASH-HOLDINGS, represented by five papers, which were cited over 730 times and gained 146 citations each (on average). This theme, based on centrality and density measures, is well developed and important to other subthemes, driving the research field forward. The papers linked to this theme discuss cash holdings in relation to the precautionary and transaction motives. Transaction motive has a robust link to corporate governance. In turn, the precautionary motive is linked to corporate governance, cash flow sensitivities, and investment decisions (cf. Figure 5, Appendix). Other topics related to cash holdings include financial management and financial constraints. The last two themes are research methodology-related, indicating country-perspective and industry-focused studies. These themes reflect the academic interest of researchers at that time, underscoring the importance of cash holdings in financial management and investment decisions under financial constraints and corporate governance mechanisms. The structure of the cluster network also reflects the discussion on cash-holding motives – precautionary or transactional.

The papers by Han and Qiu (2007) and by Guney et al. (2007) are the most important related to this cluster. The first one (Han & Qiu, 2007) is the most influential paper in the entire sample (with 500 citations) and has become a milestone in this

stream of literature. The study, using a two-period investment model, provides evidence based on the U.S. publicly traded companies from 1997-2002 that firms hold and increase precautionary savings in response to increased cash flow volatility. However, this relationship is observed only among financially constrained firms, which may face a trade-off between current and future investments. Conversely, there is no relationship between cash holdings and cash flow volatility in unconstrained firms. This suggests that cash holdings are used as a risk-management tool and to cover increased capital needs when external sources of funds are limited. This paper is regarded as the first to analyze Keynes's precautionary motive in this context and provides important guidance for financial managers.

The second most influential paper from this period investigates the impact of leverage on cash holdings (Guney et al., 2007). The study covers data from 4069 companies in France, Germany, Japan, the UK, and the US for the period 1996-2000. The pooled regression analysis reveals a non-linear relationship between leverage and cash holdings across an international sample of firms. At low debt levels, there is a negative relationship between leverage and cash holdings, driven by a substitution effect. At high debt levels, there is a positive relation between leverage and cash holdings, indicating a precautionary motive. The authors also show that the results depend partially on country-specific characteristics, e.g., the degree of creditor protection, shareholder protection, and ownership concentration. Overall, the study confirms the role cash holdings may play in risk management, as larger cash reserves are used to minimize the risk of financial distress and reduce bankruptcy costs. Therefore, this study confirms the importance of leverage for cash-holding decisions, including the effects of country-specific and firm-specific characteristics. It provides an interesting framework for further studies conducted in other countries.

In the second period under scrutiny (2010-2014), two main themes were identified as leading ones – INVESTMENT DECISIONS and BANK LOANS (cf. Figure 6, Appendix). The first leading theme, the dominant one in the research field, includes four papers and covers seven subthemes. Cash holdings are strongly linked to investment decisions, working capital management, and corporate value. Precautionary motive is related to investment decisions and the financial market. Finally, there is a strong link between capital structure decisions and macroeconomic factors related to investment decisions. This cluster strongly underscores the financial perspective in research on cash holdings and risk-related issues and illustrates academic interest during the post-crisis period.

The most influential paper in this cluster was published by Palazzo (2012). It examined the relationship between a firm's cash flows and aggregated risk, and its impact on the optimal cash-holding policy of U.S. public companies. The

proposed model uses cash flow volatility as a proxy for firm-level risk and an accounting-based measure for expected equity returns. By using the Fama and French model, the author tested whether cash holdings carry a positive risk premium. It is confirmed that firms with greater risk tend to hold more cash as precautionary savings. This motive is positively associated with expected equity returns and cash reserves. The results of this paper are of great importance not only to researchers but also to investors in the stock market seeking investment opportunities that meet their risk-return expectations.

The paper published by Acharya et al. (2012) investigated the relationship between a firm's cash reserves and credit risk. The research sample comprises 530 non-financial U.S. firms that had at least one public bond outstanding during the period 1996-2010. The results of the regression analysis indicate that the correlation between cash and default probability varies with the time horizon. Large cash reserves decrease short-term credit risk, but are associated with a higher probability of default over longer periods. This suggests that riskier firms hold more cash due to the precautionary motive, as a reserve to cover potential shortfalls, because external financing is costly or constrained. Therefore, high cash holdings do not always mean low risk, as they may reflect a response to high risk. These implications are important to other researchers, as they should consider this relation in their models, and to practitioners who analyze credit risk solely on the basis of the cash-to-asset ratio.

The second leading theme during this period is represented by a single paper that links bank loans to financial liquidity (Agénor & Aynaoui, 2010). It analyses excess cash reserves in the context of bank liquidity and contractionary monetary policy, suggesting that demand for excess cash is determined by precautionary factors and the opportunity cost of holding cash. This paper analyses cash holdings from the perspective of bank liquidity management and monetary policy, focusing on issues specific to the banking sector. From the non-financial companies' point of view, these findings are important because excess cash holdings in banks may translate into a lower risk premium and lower interest rates, leading to a lower cost of debt capital and higher availability of bank loans.

In the third period (2015-2019), two leading themes were identified – CASH HOLDINGS (the dominant one) and WORKING CAPITAL MANAGEMENT (cf. Figure 7, Appendix). The first leading theme, well developed and important to other themes, is CASH HOLDINGS and includes eight papers. The thematic network consists of 14 subthemes, connected by strong links (cf. Figure 8, Appendix). The strongest nodes are: precautionary motive (linked to financial performance, uncertainty, firm size, and information technology application) and financial constraints (linked to bank loans, strategic approach, and excess cash holdings).

Corporate governance is represented here by the subtheme of board diversity. It is examined in the most influential paper published during this period, Adhikari's (2018) study of female executives and corporate cash holdings. The results of the regression analysis confirm that U.S. publicly traded firms led by female executives tend to hold more cash for precautionary motives. It supports the view that women exhibit greater risk aversion, leading them to maintain higher cash holdings and make more conservative financial decisions. This paper contributes to the literature on how managerial characteristics, in this case gender, influence corporate cash-holding decisions.

The paper by Zheng (2019) confirms the importance of the precautionary motive in explaining high cash holdings among multinational firms. The sample comprises 4,286 U.S. firms from 1998 to 2013. The model uses a set of variables linked to firms' exposure to risk, such as cash flow volatility, market volatility, or the firm's sensitivity to U.S. economic policy uncertainty. Principal component analysis provides evidence that multinational firms hold more cash than domestic firms. High cash levels in multinational stand-alone firms are explained by their exposure to many uncertainties, including market, policy, and economic factors. In particular, market risk and economic uncertainty have a positive impact on the level of corporate cash holdings. This paper underscores the importance of macroeconomic factors in multinational enterprises' cash management decisions.

Yet another paper, by Choi and Choi (2016), analyzed determinants of corporate cash holdings. Using panel regression analysis on a sample of publicly traded Korean companies (1981-2008), they find that cash levels are determined by operating risk factors. They also observe that corporate governance, proxied by block or insider ownership, has a negative impact on corporate cash holdings, reducing the agency problem. Therefore, this paper underscores the impact of corporate governance mechanisms and operating risk on cash-holding decisions. All these papers underscore the importance of the precautionary motive for holding cash, confirming the role of cash reserves as safety buffers and risk-management tools.

The second leading theme in this period is **WORKING CAPITAL MANAGEMENT**, whose cluster consists of five subthemes. The subtheme risk is linked to the subtheme supply chain, and the subtheme Corporate Social Responsibility (CSR) connects to the subtheme consumer behavior (cf. Figure 9, Appendix). This cluster covers two papers, which examine specific topics related to working capital management, such as trade credit, inventory systems, and supply disruption.

Cheung and Pok (2019) analyzed three distinct perspectives on CSR and its relationship to trade credit practices, to find out if suppliers with strong social performance offer more trade credit to their clients. Their dataset comprises 20,591 firm-year observations from 1991 to 2015. In their empirical work, they confirm the trust

and substitution views of CSR. According to their findings, CSR builds trust and improves trade credit agreements; in contrast, accumulating cash reduces the incentive to provide trade credit. At the same time, the authors do not provide evidence for the precautionary motive of holding cash as a hedge against trade credit risk.

Finally, the recent analysis period, covering 2020-2025, provides rich and diverse studies on cash holdings and risk-related topics, as illustrated in the strategic diagram (cf. Figure 10, Appendix). Papers published during this period focus on two motor themes: the dominant theme, CASH-HOLDINGS, and the closely related theme, CASH FLOW. These themes are classified as well-developed, mature, and strongly connected to others.

The CASH HOLDINGS theme is represented by 63 papers with over 900 citations. The cluster network comprises 14 themes, indicating the richness of the examined topics and showing that cash holdings are strongly related to the precautionary motive, financial constraints, and investment decisions (Figure 11, Appendix). There are also important links between cash holdings and external factors, such as the macroeconomic situation, country perspective, and two types of risk: climate risk and geopolitical risk. This may indicate that corporate cash holdings are maintained primarily for precautionary motives as a response to the increased instability of the macroeconomic environment, in light of geopolitical risk (the COVID-19 pandemic, the Russian invasion of Ukraine, high inflation, and rising interest rates), and the growing relevance of climate risk. Another, but weaker, motive for cash holdings is linked to investment decisions under financial constraints, macroeconomic factors, country perspectives, and geopolitical risk.

The paper by Cowling et al. (2020) examined SMEs' decisions to hold cash as a precautionary reserve in the context of the COVID-19 pandemic. The research sample comprises 1,500 UK small and medium-sized firms that responded to a survey conducted in 2018-2019. It shows that, in general, SMEs were not prepared for the income shortfalls caused by pandemic-related risks, as they lacked sufficient cash reserves. They also prove that firms operating in industries with more volatile cash flows tend to hold more cash. They confirm the importance of cash holdings in building SME resilience in the face of unexpected events.

The same issue is discussed by Zheng (2022), who confirmed the importance of the precautionary motive of cash holdings during the COVID-19 pandemic. The sample comprises U.S. publicly traded companies from 2018 to 2020, covering over 30,000 firm-quarter observations. Using a natural experiment setting and a differences-in-differences approach, he found that while all firms suffered a negative impact from the COVID-19 crisis, firms with excess cash reserves prior to the crisis performed better. Therefore, he demonstrates the importance of cash holdings to mitigate the adverse effects of external shocks.

The second leading theme in this period is CASH FLOW. It covers 11 papers and has close to 160 citations overall. The cluster network comprises 12 subthemes representing a variety of research topics (cf. Figure 12, Appendix). A strong link is observed between risk preference, IT application, and strategic approach. Subtheme CSR is related to ownership structure, financial performance, strategic approach, and sustainable development.

The most influential paper on this subtheme is Zheng (2022), which examined the importance of cash holdings during the COVID-19 pandemic (briefly discussed in the previous section). Another paper by Lee et al. (2023) examined the links among cash holdings and green development, climate risk, and cash flow across 87 countries. The authors found a negative relationship between green development and cash holdings, and a positive relationship between cash holdings and the interaction between climate risk and cash flow. They also found that these links are stronger in financially constrained firms, particularly those located in countries with higher levels of green development. This relation is also more evident for Asian and European firms. They postulated that firms may be encouraged to increase cash holdings as a precautionary reserve against external shocks, including climate-related risks and strategies.

The analysis of strategic diagrams and thematic clusters across the four distinct periods identified seven main research themes, which have shaped the intellectual development of this domain. In particular, three clusters: cash holdings (2015-2019), cash holdings (2020-2025), and cash flow (2020-2025), illustrate the variety of research perspectives and evolving context of studies linking cash holdings to risk-related issues.

3.3. Identification of emerging themes in research on corporate cash holdings and risk-related issues

The emerging themes in research on corporate cash holdings and risk-related issues (RQ3) can be identified by their low centrality and low density, as they are located in the third quarter of the strategic diagrams.

The first emerging theme was identified for the first time in the third period of analysis (2015-2019) (cf. Figure 7, Appendix). This emerging theme – RISK MANAGEMENT covers only one paper and links risk management issues to corporate culture and financial management (cf. Figure 13, Appendix). The paper by Ucar (2019) analyzed U.S. publicly listed firms, whose location information allows mapping to the local creative-culture index. The results of regression analysis suggest that firms located in areas with a strong creative culture

tend to have higher risk exposure, investment, and growth. They also accumulate more cash following the precautionary motive of holding cash. This paper underscores the importance of creative culture and risk-taking in corporate financial decision-making. The study introduced a new factor to the discussion on cash holdings and risk-related issues: corporate culture, which, as an informal institution, shapes corporate risk-taking decisions.

The recent period (2020-2025) has two emerging themes: **INDUSTRY STUDIES** and **AGENCY COSTS**. The first emerging topic: **INDUSTRY STUDIES** consists of two subthemes: sovereign risk and economic policies, and covers two papers (cf. Figure 14, Appendix). Trinh et al. (2022) analyzed Australian energy firms from 2010 to 2020, examining economic policy uncertainty as a new determinant of corporate cash holdings. They used two motives for holding cash: precautionary and speculative. Interestingly, for the economic policy uncertainty (EPU), they used an index based on news coverage across eight major Australian newspapers. By using three different models: ordinary least squares, fixed-effect, and dynamic generalized method of moments, they find that the economic policy uncertainty index significantly and positively affects cash holdings. Other important determinants are growth opportunities, financial leverage, and capital expenditure. Corporate cash holdings are maintained for the precautionary motive to avoid liquidity shocks. In this way, they demonstrate that uncertainty surrounding economic policies may have a significant impact on corporate decisions regarding cash holdings and their precautionary function.

The second emerging theme is focused on **AGENCY COSTS**. It includes only one paper and is linked to the subtheme of excess cash holdings (cf. Figure 14, Appendix). Kalash (2024) examined the link between excess cash, financial performance, investment, and agency costs for 200 Turkish companies listed on the Istanbul Exchange from 2009 to 2020. The results of the dynamic regression models suggest that excess cash negatively impacts financial performance only in highly leveraged firms. The precautionary motive of holding cash is more important for firms with high investment than those with high business risk. Excess cash, together with high investment, benefits financial performance. Finally, the negative impact of excess cash on financial performance is mitigated by agency costs of debt but amplified by agency costs of equity. In this way, the study links cash management to investment and capital structure decisions in emerging markets. It also proves that investment decisions are more important than business risk in hoarding precautionary cash reserves.

Based on the analysis of strategic diagrams, the emerging themes were identified only in the last two periods (the third and fourth periods). Altogether, three emerging topics were identified, indicating potential directions for future

research. In this context, the RISK MANAGEMENT theme, identified as an emerging one for the first time in the 2015-2019 period, provides an interesting avenue for research that should be explored in future studies. This is particularly relevant with regard to the specific factors shaping the relationship between cash and risk, namely: corporate culture, economic instability, investment decisions, agency costs, leverage, and business risk.

3.4. Identification of notable gaps in research on corporate cash holdings and risk-related issues

The notable gaps in research on corporate cash holdings and risk-related issues (RQ4) can be identified through the analysis of strategic diagrams, which reveal themes in the fourth quadrant.

The only underdeveloped theme – RISK MANAGEMENT – was identified in the recent period (2020-2025). It is represented by four papers, with more than 60 citations overall. The cluster network comprises five themes, indicating the context of risk-related studies linked to corporate cash holdings (cf. Figure 15, Appendix). Some studies link risk management to financial liquidity and dividend policy. Other studies link risk to innovation, electronic payment, and the labor market. This indicates the diverse perspectives that researchers bring to risk-related studies on corporate cash holdings.

The most cited paper in this cluster is by Zheng (2022), who analyzed the impact of the COVID-19 pandemic on corporate performance (discussed in detail in the previous chapter). The results support the precautionary motive of holding cash, as during the pandemic, firms with excess cash reserves outperformed firms without such reserves. The study underlines the importance of cash holdings as a tool to mitigate the adverse effects of external shocks.

However, Wang et al. (2023) examined the impact of cybersecurity risk on corporate innovation. They employed a dataset containing 31,967 firm-year observations of the U.S. listed firms from 2006 to 2019. By using textual analysis and machine learning techniques, they construct a firm-level cybersecurity risk measure. They found that innovation is negatively affected by cybersecurity risk, which can be linked to the risk tolerance level and the precautionary cash holdings. Firms with lower risk tolerance and lower cash holdings tend to reduce their innovation due to increased cybersecurity risk.

The underdeveloped theme, which suggests a research gap and indicates a direction for further study, relates to risk management. It highlights the importance of exploring the relationship between cash holdings and risk management in the context of new and emerging risks.

4. Discussion

The intellectual development of the field of research on corporate cash holdings and risk-related issues is illustrated by the thematic evolution map (Figure 4, Appendix). The analysis of strategic diagrams and thematic networks, together with the content analysis of the most influential papers in the research sample allow for answering the research questions (as presented in Section 1). Table 1 provides a brief summary of the literature review findings – the analysis of changes in the research themes and subthemes over the last 20 years illustrates the development of this field (RQ1).

Table 1. Identified research themes and selected subthemes

Period	2005-2009	2010-2014	2015-2019	2020-2025
Main leading themes (subthemes)	Cash holdings (precautionary motive , transaction motive, cash flow sensitivities)	Investment decisions (precautionary motive , cash holdings)	Cash holdings (precautionary motive , cash flow sensitivities, excess cash holdings, uncertainty)	Cash holdings (precautionary motive , uncertainty, risk, geopolitical risk, climate risk)
		Bank loans (financial liquidity)	Working capital management (risk)	Cash flow (risk preference)
Specialized themes (subthemes)	x	x	x	Working capital management (cash flow sensitivities)
New trends (subthemes)	x	x	Risk management	Industry studies (sovereign risk)
				Agency cost (excess cash holdings)
Further research directions – research gap (subthemes)	x	x	x	Risk management (financial liquidity)

Source: Authors’ own elaboration.

In the analyzed period (2005-2025), seven leading themes were identified, which indicate the dominant narrative in this research field. These themes and their changes during the analyzed periods illustrate the main research topics (RQ2) and their development over time (RQ1). They underscore the importance of a financial management perspective on cash holdings and the relationship between risk management and cash holdings. Their evolution over time is strongly linked to global events and phenomena that shaped the business environment and attracted the interest of both managers and researchers. The appearance of the BANK LOANS theme and the INVESTMENT DECISIONS theme in the 2010-2014 period may be linked to the effect of the global financial crisis

(2008-2009) and the subsequent changes in the regulatory environment and financial system. The CASH FLOW theme identified during the 2020-2025 period may underscore the consequences of the COVID-19 crisis, energy crisis, high inflation, and rising interest rates for cash flow fluctuations and the maintenance of cash liquidity. The WORKING CAPITAL MANAGEMENT theme identified in the 2015-2019 period may indicate research focus on day-to-day operations in a relatively stable business environment. The same theme was also detected in the fourth period; however, this time as a specialized theme (niche topic). This shift from a leading theme in the third period to a specialized theme in the fourth period suggests its increasing maturity and integrity. However, it also reflects its decreasing relevance to other topics and weaker influence on the broader development of the research field.

Papers related to these main themes underscore the importance of the precautionary motive for holding cash as a reserve used to hedge various types of risk (e.g., geopolitical risk, credit risk, bankruptcy risk, pandemic risk) and as a buffer against possible cash shortfalls in the future. Firms, particularly those with financial constraints, use cash holdings as a risk management tool, providing financial flexibility and building resilience.

The new trends, identified in the third and fourth periods, represent the emerging topics (RQ3). Emerging topic INDUSTRY STUDIES illustrates the importance of industry-related factors for cash holdings and risk management decisions. Different industries are exposed to different types of risk, and they are characterized by different levels of cash liquidity. The AGENCY COSTS theme underlines the agency theory perspective on cash holdings and risk management, linking these studies to the conflict of interest between shareholders and managers. Excessive cash holdings may be used by managers for personal benefit or value-reducing projects, thereby harming shareholders; therefore, they should be monitored and limited. In this context, corporate governance mechanisms may play a significant role in maintaining corporate cash holdings by balancing agency costs and precautionary savings. Finally, the RISK MANAGEMENT theme was classified as an emerging topic in the third period, and as an underdeveloped theme in the fourth period. It suggests a significant research gap (RQ4) that should be addressed in future research by focusing on the relationship between corporate cash-holding decisions and new types of risk, such as climate risk, geopolitical risk, cybersecurity risk, or ESG risk.

The detailed analysis of thematic clusters allows for identifying the major subthemes related to cash holdings, which include: precautionary motive (indicated in all four periods of analysis), cash flow sensitivities (in three periods), excess cash holdings and financial liquidity (both in two periods), and transaction motive (only in one period).

Regarding topics related to risk and risk management, the important sub-themes include: uncertainty (identified in two periods), risk preference, risk, and specific risk types (namely, geopolitical risk, sovereign risk, and climate risk). These risk-related subthemes become more visible in the last two periods, covering 2015-2025. These observations confirm the relevance of the precautionary motive of holding cash in this field of research. They also indicate that there has been an increasing focus on risk and risk management perspectives in the studies on corporate cash holdings since 2020 (RQ1).

The bibliometric analysis of papers included in the sample shows that studies on corporate cash holdings and risk examine them by focusing on:

- Firm-specific features: firm size, ownership structure, board characteristics, CEO diversity, corporate culture. In many recent studies, cash holdings are discussed in the context of specific corporate governance mechanisms, e.g., CEO characteristics or ownership.
- Specific areas of financial management: investment decisions, capital structure decisions, dividend policy, working capital management, supply chain management, and agency costs. Special attention is paid to the problem of financial constraints that restrict a firm's access to external financing and its cash management decisions. Cash reserves are also explored as a determinant of a firm's value.
- Various types of risk: business risk, trade credit risk, default risk, liquidity risk, and bankruptcy risk.
- Various research perspectives: country perspective, industry-related studies, international or domestic markets, SMEs, multinational firms, and stock-listed companies.
- Emerging global challenges: CSR, sustainable development, COVID-19, economic fluctuations, political instability, and climate-related disruptions.
- Novel types of risk: climate risk, geopolitical risk, ESG risk, and cybersecurity risk.

The analysis shows that, within the studies using a country perspective, there is a significant lack of research on firms from Central European countries. Simultaneously, many studies are focused on U.S. firms, Asian firms (Chinese, Japanese, Korean), and firms from North Africa and the Middle East. Studies on European firms mostly use data from the UK, France, or Germany.

Regarding the industry perspective, studies have examined the financial sector (banks, insurance firms), the energy sector, agriculture and fisheries, and the hospitality industry. Less attention is paid to other sectors, such as manufacturing, healthcare, biotechnology, or IT.

Therefore, future research on risk and risk management topics in relation to corporate cash holdings may explore specific new types of risk, driven by technological, environmental, and geopolitical developments. Notably, future research may be focused on: (1) technological and cyber risks – to check if firms increase cash buffers to cover the negative consequences of cybersecurity issues or supply chain IT failures, (2) climate-related physical risks and regulatory transition risks – to explore the impact of climate-related regulations or climate adaptation strategies on cash management, (3) geopolitical and supply chain risks – to examine how firms adjust their cash management policy to increasing uncertainty in international trade.

A promising stream of research may examine the impact of climate risk on cash holdings. Huang and Yu (2025) suggested research on different manifestations of climate risk (physical risk, transition risk) and heterogeneous effects on corporate cash holdings. Da Silva Fernandes and Papadimitriou (2025) and Li and Wan (2025) also confirmed the need for studies to capture the dynamic nature of the effects of corporate climate risk on cash holdings.

The new studies may focus on the link between cash-holding decisions and ESG or sustainability-linked financing. Atif et al. (2022) underscored the lack of understanding of how much cash firms with better ESG disclosure hold across the life-cycle stages. Hasan et al. (2022) stated that the effect of firm reputation risk on cash holdings is largely unexplored. Lai et al. (2025) suggested studies on the role of ESG in addressing the conflicting motives of cash holdings, specifically precautionary motive. Cambrea et al. (2022) noted that the relationship between corporate governance and cash management warrants further investigation. In particular, board diversity, ownership concentration, CEO characteristics, or compensation can be explored as factors that impact cash and risk management practices (Cambrea et al., 2022; Khatib et al., 2022), aiming to reduce the agency problem (Akhtar et al., 2018; Choi & Choi, 2016).

Finally, new studies may examine cross-country differences (developed versus emerging economies) or industry-specific factors (energy, healthcare, agriculture, IT sectors), to determine ESG-driven risk management and cash management strategies. Gallucci et al. (2025) underlined the need for country-specific or sector-specific studies to reveal contextual nuances. Khatib et al. (2022) and El-Halaby et al. (2021) indicated a lack of research focusing on cash holdings in emerging countries. Da Costa Moraes et al. (2025) postulated more studies for private firms; however, one has to accept the scarcity of available data. Khatib et al. (2022) proposed additional studies on cash holdings in SMEs, an area that is underrepresented in the literature.

5. Conclusions

5.1. Main findings and theoretical contribution

This study has synthesized the extant literature and evolution of research on corporate cash holdings and risk-related issues, with a particular focus on the precautionary motive of cash holdings. To the best of our knowledge, it is the first literature review linking corporate cash holdings research to risk-related issues, which uses the SciMAT software. Therefore, a pioneering analysis of the scientific development of the field has been conducted to identify the main research topics guiding the academic discourse and to indicate research gaps and emerging issues that may be addressed in future studies.

Altogether, 110 academic papers published between 2005 and 2025 have been reviewed using the PRISMA recommendations, the Scopus analysis tools, and the SciMAT software. The temporal analysis of the number of publications and citations per year indicates dynamic development in this research field, particularly over the last 10 years (2015-2025). This proves the increasing importance of this research domain to economic studies. The analysis of strategic diagrams and the evolution map resulted in leading themes: CASH HOLDINGS (in three periods of analysis), CASH FLOW, INVESTMENT DECISIONS, WORKING CAPITAL MANAGEMENT, and BANK LOANS. Such main research themes underscore the dominance of the financial perspective in studies linking corporate cash holdings and risk-related issues. The emerging topics, identified in the third and fourth periods of analysis, are linked to RISK MANAGEMENT, INDUSTRY STUDIES, and AGENCY COSTS. In particular, further research is needed to examine the relationship between CASH HOLDINGS and RISK MANAGEMENT, in the context of new, emerging types of risk, as it represents a notable research gap recorded in the recent period (2020-2025).

The main contribution of our paper is to provide a comprehensive study of research on corporate cash holdings from the perspective of risk-related issues using a large dataset and big data analytics. As such, the study may serve as a reference point for researchers examining the drivers of corporate cash holdings in the context of risk-related issues, notably exploring new types of risks, e.g., ESG risk, climate risk, cybersecurity risk, or geopolitical risk.

5.2. Practical implications

Our findings highlight the multifaceted and interconnected dimensions of cash holdings and risk management decisions for managers and policymakers. They may support decision-making by financial managers and policymakers by underscoring

the complexity of the relationship between cash holdings and risk management. The agency cost theme highlights the importance of corporate governance mechanisms that balance precautionary cash holdings with effective control over managerial decisions. The industry-specific context may help managers develop strategies linking cash holdings and risk management, adjusted to the specific needs and conditions of firms operating in different sectors. The growing focus on ESG and climate risks highlights the need to integrate sustainability-related considerations into cash holding decisions and risk management practices.

5.3. Limitations

This study is not without limitations arising from the methodological choices made. Although Scopus is a primary database for business and management research, other papers not included in this analysis may have been published. Therefore, the sample may not fully represent the academic discourse in this field of research. For example, studies from regions and countries where journals are more often indexed in other databases (e.g., Web of Science) may not be captured in our research sample.

Three primary keywords were used to generate the dataset from the Scopus database. These keywords were selected after several trials to find a balance between vocabulary precision and thematic scope. However, we understand that some studies may be omitted if they use alternative terminology. Any changes in this regard could affect the dataset's content.

Finally, the SciMAT software allows the implementation of various similarity measures and clustering algorithms that affect visualization and performance analysis. Using different parameters may provide different results for the identified research themes, their structure (subthemes and related links), and evolution over time.

5.4. Future research directions

With regard to the literature review studies, further work may use other databases (e.g., Web of Science) and different bibliographic tools (e.g., VoSViewer) to conduct similar research, aiming to illustrate the current state of the art and suggest directions for its development.

Future empirical studies may focus on the relationship between corporate cash holdings and emerging types of risks, including ESG risk, climate risk, cybersecurity risk, geopolitical risk, or AI-driven issues. Studies focusing on Central European countries and other emerging economies remain underrepre-

sented; further empirical research is recommended to explore the relationship between corporate cash holdings and risk in this country-specific setting. Additionally, industry-specific factors and corporate governance mechanisms may provide promising contexts for future studies.

Therefore, future research on corporate cash holdings and risk-related issues should account for the rapidly changing business environment, creating new challenges for companies. Technological transformation, climate risk, geopolitical uncertainty, and pressure for sustainability all require researchers' attention to develop new frameworks to capture the relationship between cash policies and the risk management process. They may also provide guidance on how firms should manage cash holdings to build their resilience during periods of persistent uncertainty and global shocks.

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Conflict of interest

The authors declare that there is no conflict of interest.

Author contributions

Joanna Blach – 25% (research concept and design, collection and/or assembly of data, data analysis and interpretation, writing the article, final approval of the article).

Cristina Florio – 25% (research concept and design, writing the article, critical revision of the article, final approval of the article).

Monika Wieczorek-Kosmala – 25% (writing the article, critical revision of the article, final approval of the article).

Silvano Corbella – 25% (writing the article, critical revision of the article, final approval of the article).

Ethics statement

This study did not involve human participants and did not use personal, sensitive, or identifiable data; therefore, ethical approval was not required.

Data availability statement

No new data were created or analyzed in this study. Data sharing is not applicable.

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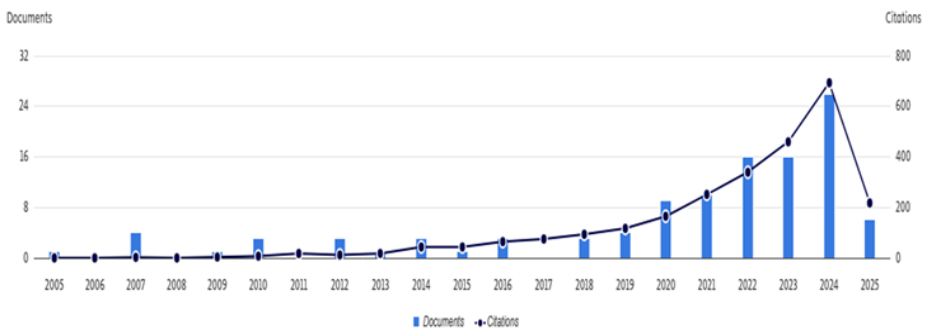
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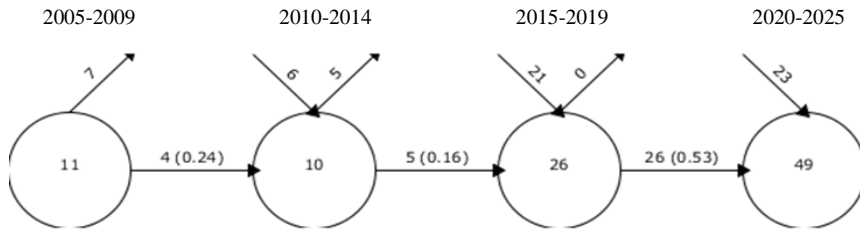
Appendix

Figure 2. Number of publications and citations per year



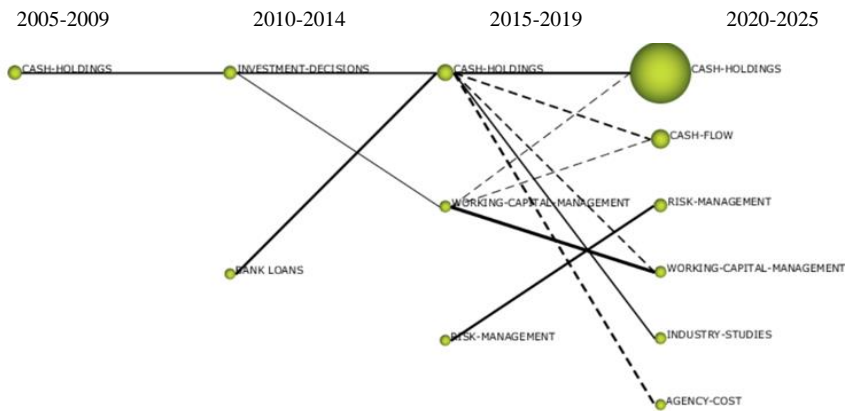
Source: Scopus database.

Figure 3. Overlapping map



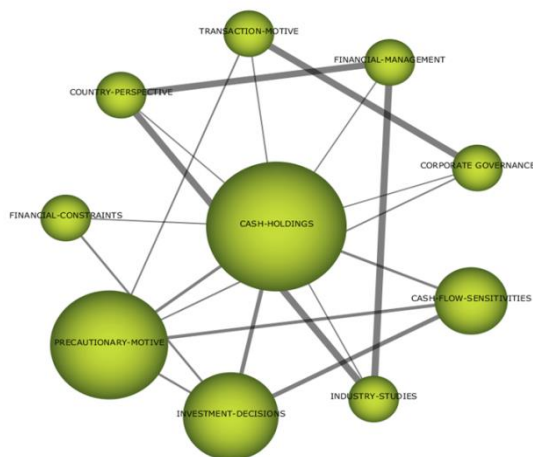
Source: Authors' own analysis using SciMAT.

Figure 4. Evolution map



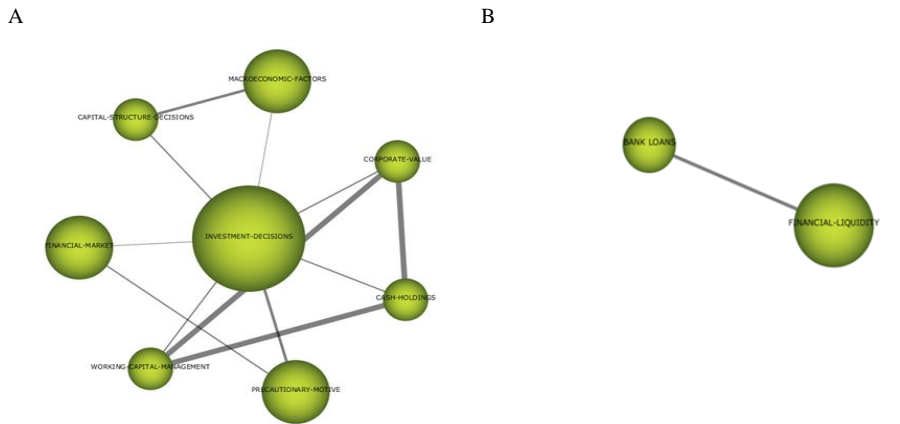
Source: Authors' own analysis using SciMAT.

Figure 5. Cluster network: CASH HOLDINGS (2005-2009)



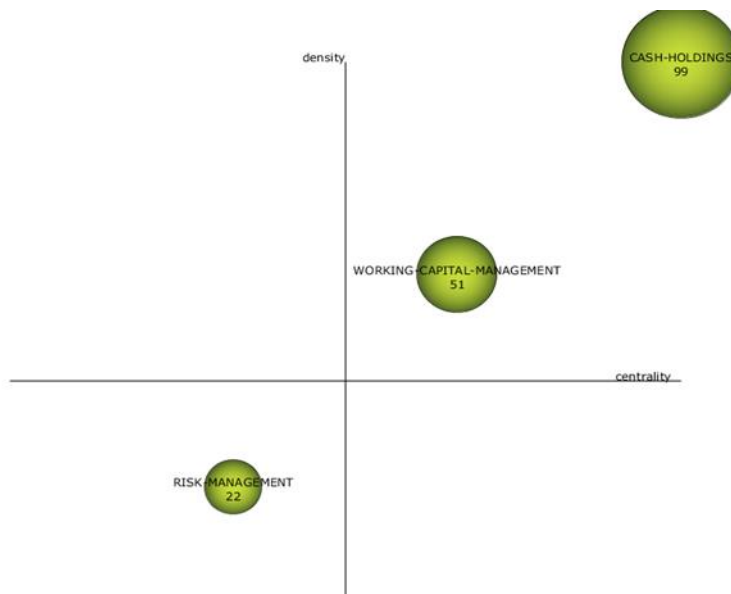
Source: Authors' own analysis using SciMAT.

Figure 6. Cluster networks: INVESTMENT DECISIONS (A) & BANK LOANS (B) (2010-2014)



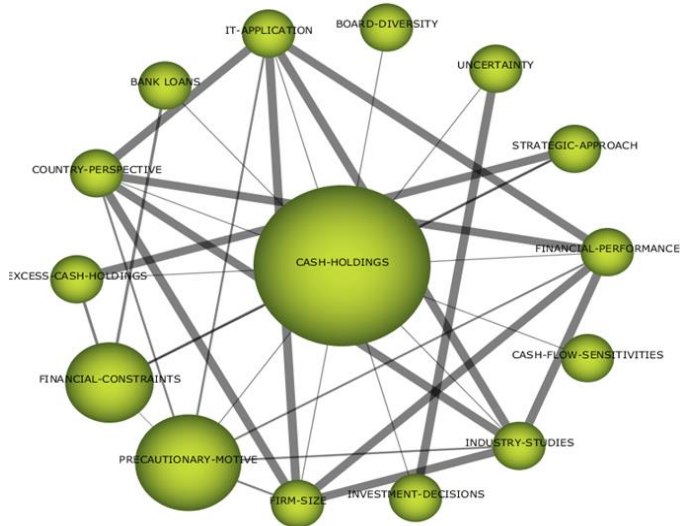
Source: Authors' own analysis using SciMAT.

Figure 7. Strategic diagram – third period (2015-2019)



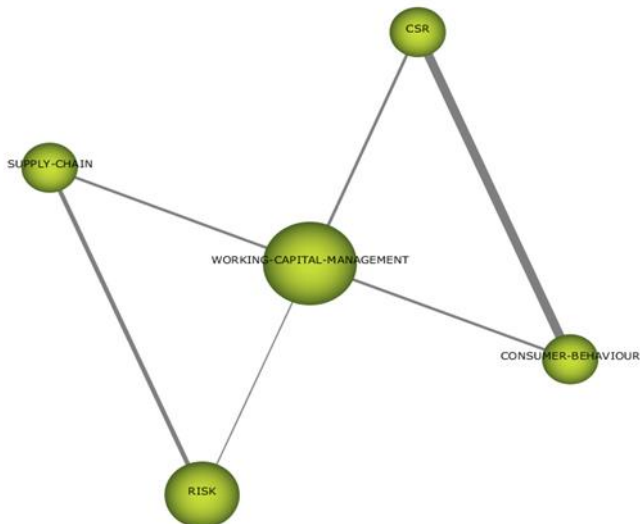
Source: Authors' own analysis using SciMAT.

Figure 8. Cluster network: CASH HOLDINGS (2015-2019)



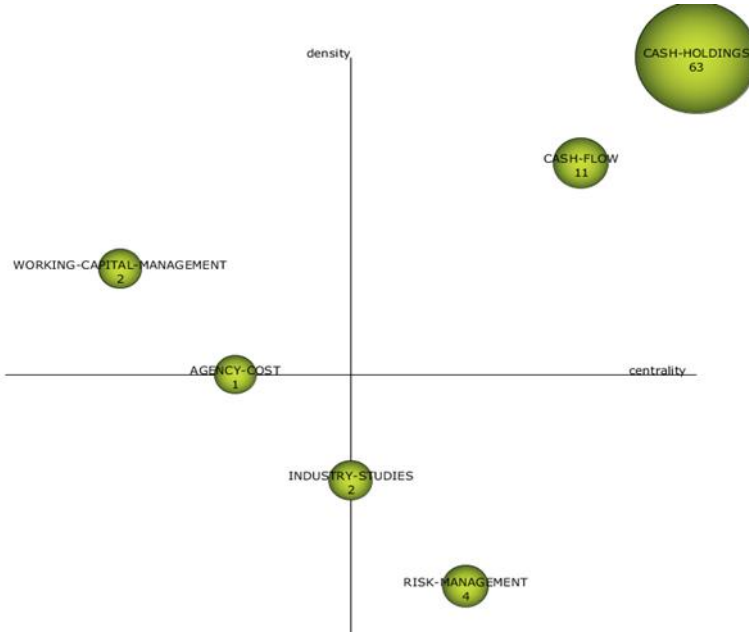
Source: Authors' own analysis using SciMAT.

Figure 9. Cluster network: WORKING CAPITAL MANAGEMENT (2015-2019)



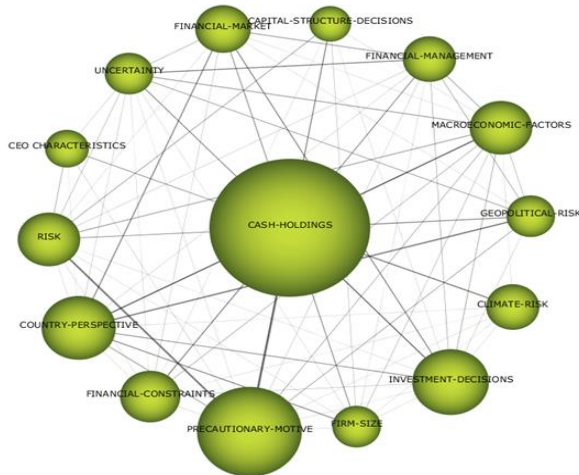
Source: Authors' own analysis using SciMAT.

Figure 10. Strategic diagram – fourth period (2020-2025)



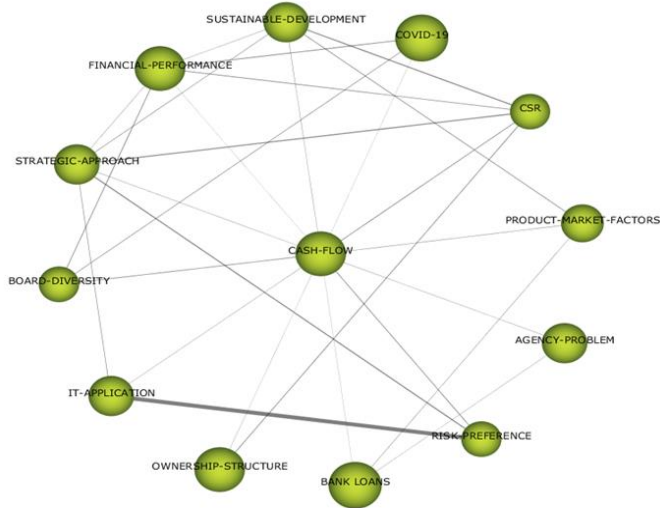
Source: Authors' own analysis using SciMAT.

Figure 11. Cluster network: CASH HOLDINGS (2020-2025)



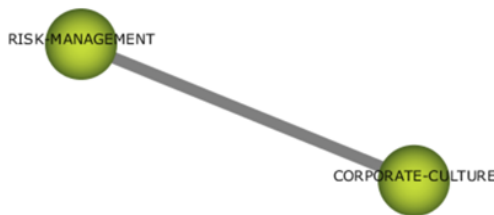
Source: Authors' own analysis using SciMAT.

Figure 12. Cluster network: CASH FLOW (2020-2025)



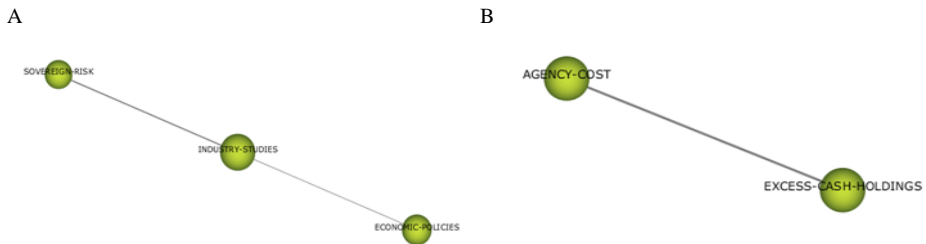
Source: Authors' own analysis using SciMAT.

Figure 13. Cluster network: RISK MANAGEMENT (2015-2019)



Source: Authors' own analysis using SciMAT.

Figure 14. Cluster network: INDUSTRY-STUDIES (A) and AGENCY COST (B) (2020-2025)



Source: Authors' own analysis using SciMAT.

Figure 15. Cluster network: RISK MANAGEMENT (2020-2025)



Source: Authors' own analysis using SciMAT.