Sectoral Differences in The Impact of Cash Holdings on Bankruptcy Risk: Evidence From Uzbekistan

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Research aim: This study aims to investigate the impact of corporate cash holdings on bankruptcy risk, with particular emphasis on sectoral differences in Uzbekistan.

Design/ Methodology/ Approach: This study uses a robust panel dataset of 299 listed firms in Uzbekistan over the period 2014-2021 (2,301 firm-year observations). Panel regression techniques are employed to examine the relationship between cash holdings and bankruptcy risk across various industry sectors.

Research finding: The findings reveal that corporate cash holdings significantly reduce bankruptcy risk, especially in the manufacturing-related industries. The sectoral analysis highlights disparities in financial resilience and risk exposure, indicating the importance of industry-specific financial strategies.

Theoretical contribution/Originality: This study provides evidence from an under-researched transitional economy, thereby enhancing our understanding of firm-level financial behaviour in emerging markets. The findings support the relevance of trade-off theory in Uzbekistan, while suggesting that free cash flow theory may require contextual adaptation.

Practitioner/Policy implication: The results underscore the need for policymakers and practitioners to adopt differentiated approaches when designing financial regulations and firm strategies. Particularly, strengthening liquidity management in the manufacturing sector can enhance corporate resilience.

Research limitation: The study is limited by its focus on a single country, potential data constraints, and the exclusion of certain variables. These limitations open avenues for future research to explore cross-country comparisons and incorporate broader macroeconomic indicators.

Keywords: Cash holding, Bankruptcy, Financial resilience, Emerging markets.
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1. Introduction

Corporate cash holdings are a fundamental element of financial management and a critical source for every company seeking to enhance its liquidity, grow investments, and strengthen its strategic resilience and sustainability. For firms in emerging economies, such as Uzbekistan, where capital markets are less developed and access to external financing is limited (Jonibekov, 2025), effective cash management is closely tied to strategic objectives of liquidity, solvency, and long-term resilience (Sayed & Khalil, 2022). This need has been further emphasised by Uzbekistan's financial reforms, including the mandatory adoption of IFRS, strengthened financial market regulations aimed at preventing insolvency, enhancements to corporate governance, and alignment with the "Uzbekistan 2030" Strategy (Olimjonova, 2025).

Bankruptcy, however, remains a severe outcome of financial fragility, with far-reaching implications. It results not only in the liquidation of assets and job losses but also in broader economic instability (Aleksanyan & Huiban, 2026). Empirical evidence suggests that insolvency often arises from undercapitalisation, poor cash management, inefficiency in resource allocation, declining sales, or technological advancements (Venkataramana et al., 2012). Bankruptcy risk persists across the entire corporate life cycle, as managers operate under resource constraints and environmental uncertainty (Rybak, 2006). Companies with weak cash flows or mismanaged liquidity are particularly exposed to bankruptcy risk (Campbell, 2011). Consequently, continuous assessment of financial health and potential risks enables the implementation of strategies to mitigate possible threats and ensure long-term sustainability.

The definition of bankruptcy varies across jurisdictions, but the inability to repay debts is a common standard (Huaiyu, 2006). In Uzbekistan, the Law on Insolvency (LRU-763, 2022) defines a bankrupt firm as one officially recognised as insolvent by court decision, triggering liquidation or restructuring. Legal scholarship emphasises that Uzbekistan's insolvency framework continues to evolve, seeking to balance creditor rights with debtor protection in line with international best practices (Hudayberganov, 2023). These changes are not only legal but also economically significant: in a transitional economy like Uzbekistan, financial defaults threaten investor confidence, undermine capital market development, and pose systemic risks to financial stability. Thus, studying bankruptcy risk is particularly important in this context, as it provides policymakers and corporate managers with valuable insights for strengthening financial resilience and promoting sustainable economic growth.

From a theoretical perspective, the relationship between cash holdings and bankruptcy risk is complex. Trade-off theory posits that firms strive to strike a balance between the benefits of liquidity and the costs of distress,

while minimising inefficiencies (Opler et al., 1999). Free cash flow theory (Jensen, 1986) suggests that excess liquidity may exacerbate agency conflicts, encouraging managerial opportunism and inefficient investments that can increase the risk of bankruptcy. These competing perspectives highlight the theoretical ambiguity surrounding the role of cash in bankruptcy prediction.

This ambiguity is reflected in empirical research. Some studies report that cash reduces bankruptcy risk by serving as a liquidity buffer (Campbell et al., 2008; Sayed & Khalil, 2022), while others argue that excessive cash increases the probability of default (Acharya et al., 2012; Zhang et al., 2022). The divergence in findings suggests that institutional frameworks, governance mechanisms, and market structure condition the role of cash, and that evidence from emerging economies is valuable. The Central Bank of Uzbekistan, in its recent Financial Stability Report (2024), has highlighted vulnerabilities in corporate sector liquidity and exposure to macroeconomic shocks, further underscoring the importance of reassessing this relationship in the national context.

Industry heterogeneity adds another dimension. Firms in different industries differ in capital intensity, operating cycles, and debt structures, which shape their exposure to insolvency. Research indicates that industry membership can significantly impact the survival of firms (Thornhill & Amit, 2003). In Uzbekistan, sectoral differences are exacerbated by uneven access to credit and varying degrees of state support (DP-3594, 2005), suggesting that the impact of cash holdings on bankruptcy is likely to be uneven across industries. A sectoral approach, therefore, provides valuable insights into how liquidity either mitigates or amplifies bankruptcy risk.

This study addresses these gaps by investigating the relationship between cash holdings and bankruptcy risk across industries in Uzbekistan, utilising a panel dataset of 299 listed firms from 2014 to 2021. The analysis integrates firm-level financial data with sectoral comparisons. The paper contributes to both theory and practice by clarifying the role of liquidity under transitional institutional conditions. The findings aim to inform financial decision-making, insolvency regulation, and corporate governance in Uzbekistan and comparable emerging economies. Placing the findings in a broader perspective, Uzbekistan represents a Central Asian emerging economy whose institutional reforms, financial reporting convergence, and sectoral differences offer insights relevant to the Asian region.

The rest of the paper is organised as follows. Section 2 reviews the literature and develops hypotheses. Section 3 outlines the methodology. Section 4 presents the results, and Section 5 provides the conclusion.

2. Literature review and Hypotheses development

2.1 *Sectoral variations in bankruptcy risk*

Bankruptcy risk varies across industries due to market structure, competition, technological change and innovations, and industry-related regulations and policies (Wellalage & Locke, 2012). Capital-intensive sectors, for example, are more often vulnerable to downturns than service-based industries with lighter financial structures. Empirical evidence consistently shows such differences. Tung and Phung (2019) found that Vietnamese manufacturing SMEs exhibited disproportionally high bankruptcy risk compared to service-oriented firms. Chava and Jarrow (2004) also confirmed that industry effects significantly shape bankruptcy predictions in the U.S., while Allianz Research (2023) reported that trade firms in Germany faced the highest insolvency rates. Likewise, Dun & Bradstreet's (2024) Global Bankruptcy Report documented construction firms in Finland, property developers in China, and restaurants in the U.K. as the most vulnerable sectors.

Despite the evidence from developed and large emerging economies, there is limited research on sectoral bankruptcy risks in transitional economies, including Uzbekistan. Most existing studies treat bankruptcy risk at the aggregate firm level, overlooking whether industry-specific factors alter risk exposure. This omission is significant because, in transitional contexts, institutional reforms and varying access to finance can amplify sectoral differences.

Uzbekistan provides a particularly relevant case. While most academic research overlooks this setting, contextual evidence suggests strong sectoral imbalances. The Central Bank of Uzbekistan's Financial Stability Report (2023) highlights the rising leverage and liquidity risks in the construction and state-owned firms. Similarly, the World Bank's Country Economic Memorandum (2025) identifies structural vulnerabilities, including the dominance of state-owned enterprises, shallow capital markets, and uneven sectoral performance, that heighten financial fragility in specific industries. Together, these insights suggest that industry-specific bankruptcy risk in Uzbekistan may diverge from patterns observed elsewhere.

Accordingly, the first hypothesis is formulated as:

H_{01}: There is no significant difference in bankruptcy risk levels across industry sectors in Uzbekistan.

2.2 *Cash holdings and bankruptcy risk across sectors*

While sectoral differences in bankruptcy risk are well-documented, equally important but less explored is how sectoral characteristics of firms influence

the relationship between cash holdings and bankruptcy risk.

Cash is universally recognised as a liquidity buffer, yet its relationship with bankruptcy risk remains contested. From a theoretical perspective, the trade-off theory posits that firms maintain cash reserves to avoid costly external financing and mitigate financial distress, suggesting that higher cash reserves reduce bankruptcy risk (Opler et al., 1999). Conversely, the free cash flow theory (Jensen, 1986) emphasises the agency costs of cash, suggesting that excess cash may encourage managerial opportunism and inefficient investment, thereby increasing bankruptcy risk.

Empirical findings reflect this theoretical ambiguity. Several scholars have empirically confirmed that cash holdings reduce bankruptcy risk. Zhou (2014) found that liquidity was crucial for Chinese firms during the global recession; Kling (2018) reported that U.S. firms with larger cash holdings faced lower bankruptcy risk; and Sayed and Khalil (2022) found similar evidence among Egyptian companies. In contrast, Zhang et al. (2022) found that excess liquidity increased the probability of bankruptcy for Chinese listed firms, while Acharya et al. (2012) observed higher long-term default probabilities in U.S. firms with abundant cash reserves. Chen et al. (2018) provided further nuance, showing that cash was more effective in helping highly leveraged firms during the 2008 financial crisis, but less effective during the 2000 dot-com crash.

One dimension that has been neglected in the literature is whether the relationship between cash and bankruptcy risk is consistent across industries. Sectoral characteristics, such as capital intensity, volatility of cash flows, and reliance on external financing, may shape the value of liquidity buffers. Arnold (2014), for instance, shows that managerial use of cash influences default probability differently across industries, depending on firm and sectoral characteristics. Prior research, however, has rarely disaggregated findings by sectors.

This gap is especially relevant in Uzbekistan, where industry-specific vulnerabilities increase the diversity of the relationship between cash holdings and bankruptcy risk, given that leverage pressure is concentrated in certain industries (CBU, 2023) and uneven state support (DP-3594, 2005).

Nevertheless, despite extensive research on cash and bankruptcy risk, little is known about how this relationship unfolds across different sectors in transitional economies, such as Uzbekistan. Existing studies typically analyse firms in aggregate, overlooking the possibility that cash holdings may reduce bankruptcy risk in some industries while having little or even an adverse effect in others. Addressing this gap, this study tests whether the cash holdings and bankruptcy risk differ across sectors in Uzbekistan.

Thus, the second hypothesis is proposed:

H_{02}: There is no significant difference in the relationship between corporate cash holdings and bankruptcy risk across industry sectors in Uzbekistan.

2.3 Summary

This review highlights two critical but under-explored areas in the corporate finance literature. First, sectoral variations in bankruptcy risk are well-documented in developed contexts but scarcely examined in transitional economies like Uzbekistan, forming the ground for H_{01}. Second, although cash holdings are theorised to influence bankruptcy risk, few studies assess whether this effect varies across industry sectors, forming the basis for H_{02}. Addressing these gaps not only enriches the theory on the relationship between cash holdings and bankruptcy risk but also offers valuable insights for policymakers, investors, and corporate managers in emerging market settings.

The following section (Section 3) outlines the research design and empirical approach used to test these hypotheses within the Uzbekistan context.

3. Methodology

3.1 Research design and sample

This study employs a quantitative, explanatory research design and applies panel regression analysis to examine the relationship between corporate cash holdings and bankruptcy risk across industry sectors in Uzbekistan. Panel data methods are suitable for controlling unobservable firm-specific heterogeneity and capturing both cross-sectional and time-series variation in financial behaviour (Baltagi, 2008).

The research population comprises 614 companies listed in the State register of the Republic of Uzbekistan, including 467 non-financial and 147 financial institutions. Financial institutions were excluded due to their distinct regulatory framework.

A two-step validation procedure was applied to the 467 non-financial listed companies to ensure data quality. First, financial information obtained from the Corporate Information Portal (newopeninfo.uz) was cross-verified against company websites and auditor reports. Second, reported figures were cross-checked across consecutive years to confirm internal consistency. Firms were excluded if their annual reports were inconsistent, incomplete, or not published in accordance with the Law on the Securities Market of the Republic of Uzbekistan (2008). Following this process, 174 companies were excluded, leaving a final sample of 293 non-financial firms. This yielded 2,301 firm-year observations for the period from 2014 to 2021 (Table 1).

The study period begins in 2014, following the introduction of mandatory disclosure requirements under the Law on Joint Stock Companies and Protection of Shareholders' Rights of the Republic of Uzbekistan (2014),

since from 2022 onwards all listed firms were required by Presidential Decree (2021) to adopt International Financial Reporting Standards (IFRS). The IFRS transition created a structural break in reporting standards; thus, restricting the analysis to 2014-2021 ensures methodological consistency and reliability.

Table 1: Sampling Procedure

Stages	Description	Number of firms
Population	Total listed companies	614
Screening	Excluded: financial institutions	-147
Non-financial firms	Remaining listed companies	467
Validation	Excluded: inconsistent/incomplete annual reports	-174
Final sample	Firms with complete/consistent annual reports	293
Observations	Firm-year observation for the period 2014-2021	2301

Note: The number of listed companies reflects the latest available data and is presented for information purposes only.

Finally, based on companies' tax identification numbers, information about industry classification was obtained from the National Statistics Committee website. Firms were divided into seven sectors: food manufacturing, other manufacturing, services, wholesale, retail, real estate, and construction. Food manufacturing firms were separated due to stricter food safety and quality regulations that shape their financial and risk profiles.

Table 2: Sample Selection

Industry	Number of companies	Firm-year observations
Food manufacturers	60	470
Other manufacturers	84	659
Service companies	40	311
Wholesale companies	20	160
Real Estate Companies	68	534
Retail companies	5	40
Construction companies	16	127
Total	293	2301

3.2   Measurement of variables

3.2.1 Dependent variable (Bankruptcy risk)

In this study, the bankruptcy risk of listed non-financial companies in Uzbekistan is the dependent variable. Altman's Z-score (1968) and Springate's S-score (1978) served as a proxy for the bankruptcy risk level in Uzbek companies. Altman's Z-score was used as the primary proxy, and Springate's S-score was employed as an alternative proxy for bankruptcy risk in the robustness tests.

Altman's (1968) Z-score model, introduced by Edward Altman in 1968, was employed to predict the probability of companies going bankrupt. The original model defined the fourth component as the market value of equity divided by the book value of debt. However, subsequent studies in emerging economies, for example, Egypt (Sayed & Khalil, 2022) and Indonesia (Muthia et al., 2024), have applied the market value of equity divided by total liabilities. Following this approach, this study adopts total liabilities as the denominator. This choice is further supported by Altman's retrospective reflections (Altman, 2018).

Thus, for further data analysis, the dependent variable, Z-score, is calculated based on the following model:

$$Z - score = 1.2\left(\frac{WC}{TA}\right) + 1.4\left(\frac{RE}{TA}\right) + 3.3\left(\frac{EBIT}{TA}\right) + 0.6\left(\frac{MVE}{TL}\right) + 1.0\left(\frac{S}{TA}\right)$$

Where:
WC   – Working capital,
TA   – Total assets,
RE   – Retained earnings,
EBIT – Earnings before interest and tax,
MVE – Market value of equity,
TL   – Total liabilities,
S   – Sales.

If the calculated Z-score is above 2.99, the company is in the safe zone; if it is below 1.81, it is considered to be in the zone with a strong probability of bankruptcy. Between 1.81 and 2.99 is a grey zone, indicating no strong probability of bankruptcy, but not financially healthy enough (Altman, 1968; Altman, 2018; Hantono, 2019; Sayed & Khalil, 2022).

For robustness analysis, Springate's S-score (S-score) was also applied. Based on the model, if the S-score is calculated to be more than 0.862, the company is in the non-distress zone; if the score is below 0.862, the company is in the distress zone (Springate, 1978; Yendrawati & Adiwafi, 2020).

The model is defined as:

$$S - score = 1.03\left(\frac{WC}{TA}\right) + 3.07\left(\frac{EBIT}{TA}\right) + 0.66\left(\frac{EBT}{CL}\right) + 0.4\left(\frac{S}{TA}\right)$$

Where:

WC   – Working capital,
TA   – Total assets,
EBIT – Earnings before interest and tax,
EBT – Earnings before tax,
CL   – Current liabilities,
S   – Sales.

3.2.2 Independent variable (Corporate cash holdings)

Corporate cash holding (Cash) is an independent variable in this study. Following the approach of seminal works (Opler et al., 1999; Gombola et al., 1987) and subsequent applications in emerging markets (Alimov, 2014), cash holdings are measured as:

$$Cash = \frac{Cash\ and\ cash\ equivalents}{Total\ assets - Cash\ and\ cash\ equivalents}$$

This ratio captures the liquidity buffer available to firms relative to their asset base while avoiding double-counting cash in the denominator.

3.2.3 Control variables (Firm age and size)

To isolate the effect of cash holdings on bankruptcy risk, firm-level control variables are included. Consistent with prior research, firm size (Size) was calculated as the natural logarithm of total assets (Lukason, 2018; Sayed & Khalil, 2022). The firm age (Age) was calculated as the natural logarithm of the number of years from the establishment to the end of the fiscal year (Samosir, 2018).

Table 3: Summary of Variable Measurements

Variables	Computation	Reference studies
Dependent variable (Bankruptcy risk)		
Z-score	Altman's Z-score	Altman (1968), Altman (2018), Sayed & Khalil (2022), Muthia et al. (2024), Springate (1978), Yendrawati & Adiwafi (2020)
S-score	Springate's S-score	
Independent variable (Cash holding)		
Cash	Cash and cash equivalents / total assets - Cash and cash equivalents	Opler et al. (1999), Gombola et al. (1987)

Variables	Computation	Reference studies
Control variables (Firm age and size)		
Age	Number of years from the establishment	Samosir (2018)
Size	Natural logarithm of Total Assets	Lukason (2018), Sayed and Khalil (2022)

3.3 Research techniques

The empirical analysis was structured to address the two null hypotheses of this study. To test whether bankruptcy risk significantly differs across industry sectors (H_{01}), a one-way ANOVA was employed, followed by Tukey's Honest Significant Difference (HSD) post hoc test to identify pairwise differences between sectors. This approach directly addressed H_{01}, which tests for heterogeneity in bankruptcy risk levels across industries.

To examine whether the impact of corporate cash holdings on bankruptcy risk varies across industry sectors (H_{02}), panel regression was estimated separately for each industry sector (food manufacturing, other manufacturing, services, wholesale, retail, real estate, and construction), while controlling for firm size and age.

Model specification was guided by diagnostic testing. The Breusch-Pagan test (Breusch & Pagan, 1979) for heteroscedasticity was statistically significant across all sectors ($p<0.001$), indicating the presence of heteroscedasticity in the dataset. Accordingly, all regressions were estimated using robust standard errors (Yobero, 2016).

The Hausman specification test (Hausman, 1978) was employed to determine the most suitable panel data model. The results generally yielded probabilities above the 5% threshold, suggesting that the random effects (RE) model was more efficient and appropriate than the fixed effects (FE) model for the analyses.

Multicollinearity was also assessed using the Variance Inflation Factor (VIF) (Gujarati & Porter, 2009). With a mean of less than 2.00 across the explanatory variables, this confirms that multicollinearity did not pose a concern in the regression models.

Based on the diagnostics, sector-level random effects panel regressions with robust standard errors were employed. For robustness checks, all regressions were re-estimated using Springate's S-score as an alternative proxy for bankruptcy risk, and all statistical analyses were conducted in Stat 17.

4. Findings and discussion

4.1 Descriptive statistics of variables

Table 4 shows the descriptive statistics of variables. The mean cash holding (*Cash*) is 0.04, ranging from 0.00 to 1.49, indicating that cash and equivalents represent an average of 4.25% of the total assets, relative to non-cash total assets (Table 3). The average bankruptcy risk score (Z-score) is 1.60, with a minimum score of -8.99 and a maximum of 24.63. This indicates that, on average, Uzbek companies were in the 'Distress zone' with a Z-score less than 1.81 (Altman, 1968; Altman, 2018; Hantono, 2019; Sayed & Khalil, 2022) for the period.

Firm-specific characteristics also show heterogeneity. The average age (Age) of the companies is 23 years, ranging between 1 and 85, reflecting the presence of both new and long-standing companies, with several decades of operation. The average size (in terms of the logarithm of total assets) of the companies is 10.6632, ranging from 6.29 to 17.22. This range reflects substantial variation in firm size within the sample, indicating the dataset includes both small and large companies.

Table 4: Descriptive Statistics of Variables

Variable	Mean	St. Deviation	Min	Max	Skewness	Kurtosis
Cash	0.04	0.11	0.00	1.49	5.84	48.36
Z-score	1.60	1.54	-8.99	24.63	1.83	27.09
Age	22.92	7.22	1	85	2.94	22.25
Size	10.66	1.55	6.29	17.22	0.32	3.86

Table 5 reports the correlation matrix. A positive and significant correlation is observed between cash holdings and Z-score (0.20, p<0.001), suggesting that firms with higher liquidity face lower bankruptcy risk. Cash is negatively correlated with firm age (-0.11, p < 0.001), indicating that cash holding levels are lower for older firms than for younger ones. Both firm age (-0.07, p<0.001) and firm size (-0.19, p<0.001) negatively correlated with Z-score, indicating that larger and more mature firms are more exposed to bankruptcy risk in the Uzbekistan context.

Table 5. Correlation Matrix

	Cash	**Z-score**	**Age**	**Size**
Cash	1			
Z-score	.20**	1		
Age	-.11**	-.07**	1	
Size	-.03	-.19**	.06**	1

Notes: **= significant at the 0.01 level (2-tailed).

4.2 Descriptive statistics of variables by industry sectors

Table 6 below presents the descriptive statistics for the variables, encompassing data from 293 companies across industry sectors for the years 2014-2021. Cash holdings exhibit notable variation across industries. The mean value ranges between 0.01 and 0.10. Service sector companies have a mean value of 0.10, the highest among others. This indicates that cash and equivalents account for approximately 10% of the total assets, on average, relative to non-cash assets. In contrast, real estate companies held only 1%, reflecting the sector's reliance on long-term financing and asset-backed borrowing, where firms prioritise illiquid investments over liquidity buffer. The maximum value ranges between 0.12 (retail sector) and 1.49 (service sector), indicating higher disparities across industry sectors.

Table 6. Descriptive Statistics of Wariables by Industry Sectors

Variables	Observations	Mean	St. Deviation	Min	Max	Skewness	Kurtosis
			Construction sector				
Cash	127	0.05	0.14	0.00	1.15	5.28	35.26
Z-score	127	1.55	1.14	-1.84	5.81	0.69	4.94
Age	127	23.78	9.12	4	56	1.59	7.39
Size	127	10.10	1.18	7.81	12.42	0.06	2.26
			Food manufacturing sector				
Cash	470	0.03	0.07	0.00	0.77	4.31	28.45
Z-score	470	1.65	1.35	-2.47	7.87	0.81	4.94
Age	470	23.74	4.30	15	41	1.38	5.57
Size	470	11.13	0.94	8.69	13.20	-0.32	2.27
			Manufacturing sector				
Cash	659	0.04	0.08	0.00	0.70	3.70	20.64
Z-score	659	1.73	1.37	-2.38	6.83	0.62	3.82
Age	659	23.83	8.82	3	85	3.72	24.14
Size	659	11.21	1.76	6.90	17.22	0.32	3.64
			Real estate sector				
Cash	534	0.01	0.04	0.00	0.61	6.80	67.42
Z-score	534	1.18	1.95	-9.00	24.63	3.38	44.27
Age	534	21.80	5.33	10	60	3.62	26.02
Size	534	9.800	1.32	6.29	16.44	-0.12	3.14
			Retail sector				
Cash	40	0.02	0.03	0.00	0.12	1.66	5.11
Z-score	40	1.94	1.23	-0.23	4.75	0.22	2.37
Age	40	18.70	4.17	10	27	-0.09	2.34
Size	40	11.00	1.81	8.99	14.40	0.56	1.63

Variables	Observations	Mean	St. Deviation	Min	Max	Skewness	Kurtosis
			Service sector				
Cash	311	0.10	0.22	0.00	1.49	3.24	14.60
Z-score	311	1.91	1.44	-1.51	6.97	0.46	2.90
Age	311	21.35	9.08	1	61	1.31	8.85
Size	311	10.54	1.70	7.13	15.94	0.65	3.20
			Wholesale sector				
Cash	160	0.02	0.08	0.00	0.92	7.82	75.84
Z-score	160	1.62	1.44	-1.26	9.18	1.44	7.54
Age	160	24.00	5.47	15	46	1.94	7.71
Size	160	10.47	1.02	7.25	13.56	-0.08	4.35

The Z-score levels also exhibit notable variations across sectors. The mean value ranges from 1.18 (real estate sector) to 1.94 (retail sector), suggesting real estate companies were in the zone with a strong probability of bankruptcy (Z<1.8), while retail sector companies are in a grey zone (1.8<Z<2.99) indicating no strong probability of bankruptcy but not considered financially healthy enough (Altman, 1968). The lowest recorded value is -8.99, substantially below the others, suggesting that it is the riskiest company in the real estate sector. Interestingly, the highest Z-*score* (24.63) was also observed in the real estate sector, almost three times higher than the next highest value (9.18) in the wholesale sector.

The largest company in terms of size was observed in the manufacturing sector, with a maximum value of 17.28. Conversely, the smallest company was observed in the real estate sector, with a minimum value of 6.29. Regarding firm age, the average age is the same for four sectors: construction, food manufacturing, manufacturing, and wholesale. The oldest company was observed in the manufacturing sector (85 years), while the youngest was observed in the service sector (1 year).

Overall, these variations across industries highlight the heterogeneous nature of bankruptcy risk and liquidity management in Uzbekistan. They underscore the importance of formally testing sectoral differences in bankruptcy risk and the role of industry characteristics in shaping the relationship between cash holdings and the risk of bankruptcy.

4.3. Analysis of variations in bankruptcy risk levels across industry sectors (H_{01})

To test H_{01}, a one-way ANOVA was conducted using both Altman's Z-score and Springate's S-score as an alternative proxy for bankruptcy risk. The results presented in Table 7 indicate statistically significant differences across sectors in both models. Using Altman's Z-score, the differences were

significant (F (6,2294) =10.13, p<0.001), with the between-groups sum of squares equal to 59.35. Similarly, Springate's S-score confirmed significant differences (F (6,2294) =8.65, p<0.001), with the between-groups sum of squares equal to 50.89. These findings suggest that industry membership has a systematic influence on bankruptcy risk levels.

Bartlett's tests of equal variances further revealed significant heterogeneity in both models ($\chi^2(6)$ = 128.10, p < 0.001 for the Z-score; $\chi^2(6)$ = 128.10, p < 0.001 for the S-score), indicating that the assumption of homogeneity of variance was violated. This result highlights the presence of heteroscedasticity across sectors and underscores the necessity of post hoc procedures.

Table 7: One-way ANOVA Results in Differences in Z-scores Across Industry Sectors

Model	Source	SS	DF	MS	F	P>F
Altman's Z-score	Between groups	59.354	6	9.892	10.13	0.0000
	Within groups	2240.646	2294	0.977		
	Total	2300	2300			
Springate's S-score	Between groups	50.892	6	8.482	8.65	0.0000
	Within groups	2249.108	2294	0.980		
	Total	2300	2300			

Notes:

Bartlett's tests indicate heteroscedasticity in both models (p<0.001)

SS = sum of squares; DF = degrees of freedom; MS = Mean of Square; F = F-statistic; P>F = significance level.

Tukey's HSD post hoc tests (Table 8) were conducted to identify specific sectoral contrasts. For Altman's Z-score, real estate companies consistently exhibited significantly lower financial health compared to food manufacturing (p<0.001), other manufacturing (p<0.001), service (p<0.001), retail (p=0.037), and wholesale (p=0.024). This result confirms that the real estate sector faced systematically higher bankruptcy risk during the study period.

For Springate's S-score, the pattern was consistent. Real estate companies exhibited significantly higher distress probabilities compared to construction (p<0.001), food manufacturing (p < 0.001), other manufacturing (p<0.000), service (p = 0.008), and wholesale (p = 0.001) industries. Additionally, service companies showed significantly lower distress scores compared to real estate firms, further reinforcing the vulnerability of the real estate sector.

These results underscore the structural vulnerabilities of the real estate sector in Uzbekistan, where firms are disproportionately exposed to leverage and cyclical fluctuations.

Taken together, the results of both ANOVA and Tukey's HSD post hoc tests provide sufficient evidence to reject H_{01}, which posited that there are no significant differences in bankruptcy risk levels across industry sectors in Uzbekistan. Instead, the findings confirm that bankruptcy risk is sector-specific, with the real estate sector consistently emerging as the most vulnerable.

Table 8: Tukey's HSD Post Hoc Test Results

Model	Contrast	Std. Err	t	P>t
	Real Estate vs Food Manufacturing	0.0625	-4.87	0.000
	Real Estate vs Other Manufacturing	0.0575	-6.19	0.000
Altman's Z-score	Retail vs Real Estate	0.1620	3.05	0.037
	Service vs Real Estate	0.0705	6.71	0.000
	Wholesale vs Real Estate	0.0897	3.20	0.024
	Real Estate vs Construction	0.0977	-4.68	0.000
	Real Estate vs Food Manufacturing	0.0626	-6.16	0.000
Springate's S-score	Real Estate vs Other Manufacturing	0.0576	-4.68	0.000
	Service vs Real Estate	0.0706	3.51	0.008
	Wholesale vs Real Estate	0.0892	4.04	0.001

Notes:

The table includes only the significant results (p<0.001).

Std. Err. = Standard Error; t = t-statistic; P>t = significance level.

These results establish clear sectoral differences in financial vulnerability, particularly the heightened bankruptcy risk of the real estate sector. Building on this, the following analysis investigates whether the relationship between cash holdings and bankruptcy risk also differs systematically across industry sectors.

4.4 *Analysis of the relationship between corporate cash holdings and bankruptcy risk across industry sectors (H_{02})*

The regression results reported in Table 9 provide sector-specific insights into the relationship between corporate cash holdings and bankruptcy risk, measured using both Altman's Z-score and Springate's S-score.

For the food and other manufacturing sectors, cash holding has a strong positive effect on financial health across both models (Z-score: 2.28 and 3.15; S-score: 3.07 and 2.99, all significant at the 1% level). This implies that higher liquidity significantly reduces bankruptcy risk in production-oriented industries.

By contrast, construction and service sectors show no significant association between cash and bankruptcy risk, suggesting that liquidity buffers play a limited role in safeguarding against distress in these industries.

The real estate sector exhibits inconsistent results across the two models. This may reflect the sector's structural reliance on long-term assets and leverage, where cash reserves are less decisive compared to debt management. Notably, firm age is negatively associated with solvency in this sector (β = -0.085, p < 0.001, Z-score model), indicating that older firms are more vulnerable to distress, possibly due to asset rigidity and debt accumulation over time.

In the retail sector, the effect of cash is not significant under the Z-score model but becomes positive and significant under the S-score model (β = 10.33, p < 0.05). This suggests that liquidity provides a buffer against distress when bankruptcy risk is measured with liquidity-sensitive models, aligning with the retail industry's reliance on cash flow for day-to-day operations. Age also negatively predicts solvency in this sector (β = -0.151 and -0.064, p < 0.001 and p<0.05, respectively), further highlighting the vulnerability of older retailers in a competitive and rapidly evolving market environment.

For wholesale firms, cash is positively related to solvency only in the S-score model (β = 3.01, p < 0.001), while results under the Z-score model are not significant. This again suggests that cash buffers matter more when bankruptcy risk is proxied by measures sensitive to liquidity conditions.

Table 9: Results of Analyses by Industry Sectors

Sectors	Cash (β)	Age(β)	Size(β)	R2	Wald χ^2	P> χ^2
		Z-score				
Construction	0.9110 (1.44)	-0.0211 (-1.12)	-0.2177 (-1.75)	0.035	6.60	0.085
Food manufacturing	2.2834** (3.51)	0.0100 (0.52)	-0.2297* (-2.34)	0.157	19.57	0.000
Other manufacturing	3.1525** (5.29)	0.0008 (0.09)	-0.1824** (-3.97)	0.111	45.40	0.000
Real estate	2.7850 (1.74)	-0.0851** (-4.09)	-0.2865** (-3.28)	0.102	36.30	0.000
Retail	8.2885 (1.40)	-0.1510** (-3.49)	-0.1185 (-1.33)	0.561	46.09	0.000
Service	0.1034 (0.35)	0.0191 (1.38)	-0.2778** (-3.86)	0.195	16.16	0.001
Wholesale	1.8084 (1.54)	-0.0141 (-0.50)	-0.2828* (-2.22)	0.073	8.34	0.395

Sectors	Cash (β)	Age(β)	Size(β)	R2	Wald χ²	P> χ²
S-score						
Construction	0.7821 (1.62)	-0.0152 (-1.17)	-0.0364 (-0.41)	0.093	4.76	0.190
Food manufacturing	3.0651** (3.32)	-0.019 (-0.88)	-0.266* (-2.51)	0.089	23.14	0.000
Other manufacturing	2.9889** (2.97)	0.0056 (0.42)	-0.0788 (-1.24)	0.041	10.41	0.015
Real estate	5.5578 (1.76)	-0.0223 (-0.57)	-0.915** (-5.63)	0.172	39.49	0.000
Retail	10.332* (2.56)	-0.0644* (-2.18)	-0.0776 (-1.28)	0.564	46.56	0.000
Service	0.5366 (0.79)	0.0131 (0.68)	-0.3277** (-3.2)	0.060	12.53	0.005
Wholesale	3.0137* (2.04)	0.0132 (0.40)	-0.2233 (-1.44)	0.136	7.29	0.063

Notes:

Coefficients reported with z-statistics in parentheses.

**=p<0.01; *=p<0.05

R2 = R squared overall; P> χ² = significance level.

Firm size consistently shows a negative and significant relationship with solvency across multiple sectors, including food and other manufacturing, real estate, services, and wholesale. This suggests that larger firms in Uzbekistan may carry a higher risk, potentially due to heavier debt burdens over time or inefficiencies in resource allocation.

Overall, the findings lead to the rejection of H_{02}, as the impact of cash holdings on bankruptcy risk clearly varies across industry sectors. Substantial liquidity benefits were identified in food and other manufacturing sectors, while retail and wholesale displayed conditional effects depending on the bankruptcy risk model applied. By contrast, construction, real estate, and service sectors exhibited no consistent or significant relationship between cash holdings and solvency. These results underscore that the relationship between cash holdings and bankruptcy risk is not uniform across industries in Uzbekistan, but instead reflects sector-specific financial structures, operational characteristics, and regulatory environment.

4.5   Discussion of the findings

The findings confirm that bankruptcy risk significantly differs across industry sectors, rejecting H_{01}. Both ANOVA and Tukey's post hoc test

revealed that companies operating in the real estate sector exhibited significantly higher bankruptcy risk than food and other manufacturers, as well as retail, service, and wholesale firms. The capital-intensive nature of the real estate sector may explain this, as it requires substantial upfront investment, primarily funded by debt, and lengthy project cycles (Li, 2024). These characteristics of the sector increase firms' exposure to financial distress, especially during periods of uncertainty or rising interest rates, which reduces demand for the property. This aligns with an understanding that industry-specific factors, such as capital intensity, market structure and competition, technology and innovations, and industry-related regulations and policies (Wellalage & Locke, 2012), play a significant role in shaping the company's financial conditions. Our results are consistent with prior findings by Tung and Phung (2019) and Chava and Jarrow (2004), which support the assumption that bankruptcy risk levels differ across industry sectors.

Regarding the country context, according to Dun & Bradstreet (2024), the property sector was the most stressed in China, which aligns with our results. However, our findings specific to Uzbekistan differ from those of Germany, where the trade sector was the riskiest, while in Italy, the manufacturing and service sectors were the most significant contributors to bankruptcy filings. These differences emphasise the importance of considering sectoral characteristics and macroeconomic conditions when studying bankruptcy risk. The robustness of our findings, as demonstrated by regression analysis and alternative models (Springate's S-score), further strengthens the reliability of the results. By identifying sector-specific bankruptcy risk in Uzbekistan, this study extends the literature by reinforcing the need for industry-adjusted risk assessments and addressing the first research question posed in the study.

The analysis of the relationship between corporate cash holdings and bankruptcy risk produced nuanced results, partially rejecting H_{02}. In line with trade-off theory, cash holdings significantly reduced bankruptcy risk in food and other manufacturing sectors across both Altman's Z-score and Springate's S-score models. These findings align with prior studies that have found liquidity buffers mitigate bankruptcy risk in developing countries (Sayed & Khalil, 2022; Zhang et al., 2022). This suggests that cash holding is important in mitigating bankruptcy risk in manufacturing companies, potentially due to their high fixed costs and capital-intensive nature.

By contrast, the relationship was statistically insignificant in the construction, service and real estate sectors. This pattern challenges the predictions of trade-off theory, which anticipate a consistent protective role of cash across industries. At the same time, the absence of a significant positive effect of cash holdings on bankruptcy risk means the results do not lend direct support to free cash flow theory, which predicts that excess liquidity increases financial fragility (Jensen, 1986; Acharya et al., 2012).

Instead, the insignificance may reflect structural inefficiencies or governance constraints that diminish the role of the cash in mitigating bankruptcy risk. These results align with studies that demonstrate cash reserves do not consistently mitigate default risk under specific economic conditions (Chen et al., 2018).

Additional insights emerged from the control variables. Firm age was negatively associated with financial health in the real estate and retail sectors, indicating that older firms in these industries face a greater bankruptcy risk, possibly due to outdated business models or accumulated debt over time. Firm size was also significantly negative in several industries, including food and other manufacturing, real estate, service and wholesale. This suggests that larger firms in Uzbekistan are not necessarily safer; instead, their size may expose them to higher financial risks.

Taken together, the findings indicate that while cash reserves play a stabilising role in manufacturing industries, their impact is contingent on sectoral characteristics. The results contribute to clarifying the theoretical ambiguity in the literature, showing that the trade-off theory holds under specific sectoral conditions. In contrast, the assumptions of free cash flow theory are challenged in the Uzbekistan context.

5. Conclusion

This study examined sectoral differences in bankruptcy risk and the role of cash holdings in reducing bankruptcy risk in the context of Uzbekistan, using panel data from 293 listed non-financial firms between 2014 and 2021. The findings revealed clear sectoral disparities: real estate firms were consistently more fragile than firms in food, manufacturing, retail, service, and wholesale sectors, underscoring the importance of sector-specific vulnerabilities in shaping financial resilience. Regarding cash holdings, the results confirmed the predictions of trade-off theory in manufacturing-related industries, where liquidity buffers significantly reduced the bankruptcy risk. Contrarily, in construction, service, and real estate, cash holdings had no significant effect, suggesting that structural and governance inefficiencies may limit the protective role of liquidity. These patterns challenged the free cash flow theory predictions, as excess cash did not translate into increased bankruptcy risk.

The findings of this study have several implications. For firms, particularly in manufacturing, maintaining cash reserves appears essential for absorbing cyclical shocks and reducing reliance on external financing. For policymakers, the results underscore the need for sector-specific reforms, particularly in the real estate sector, where systemic vulnerabilities persist. For investors and creditors, the evidence confirms that the bankruptcy risk varies by sector, requiring financial assessments that account for these

differences rather than treating cash holdings as uniformly protective.

At the same time, certain limitations must be acknowledged. The analysis covered only listed non-financial firms, which may differ from privately held and financial firms in governance structures and financial access. Bankruptcy risk was measured using accounting-based proxies, which, although widely recognised, may not capture forward-looking market signals. Moreover, the dataset was limited to the period 2014-2021, which included COVID-19 shocks and pre-IFRS adaptation, but not the post-COVID-19 and post-IFRS consolidation phases in Uzbekistan. These limitations suggest avenues for future research. Expanding the scope to include unlisted firms, incorporating market-based indicators of distress, and extending the timeframe would provide a more comprehensive picture. Comparative work across other developing economies also helps establish whether the sectoral patterns observed in this study reflect broader dynamics.

In conclusion, this study contributes to a deeper understanding of bankruptcy risk in emerging markets by revealing the firm-level financial behaviour. It calls for more nuanced theories, data-driven policymaking, and adaptive financial strategies that reflect the complexities and realities of firms operating in transitional economic systems. These insights directly aligned with the "Uzbekistan 2023" Strategy, which emphasises strengthening financial resilience, improving corporate governance, and fostering sustainable growth.

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