

Retraction

Retracted: Empirical Research on the Relationship between Industry Working Capital Shortfall and Company Cash Holding in the Same Industry

Discrete Dynamics in Nature and Society

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

Copyright © 2024 Discrete Dynamics in Nature and Society. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] Z. Li, J. Jiang, L. Xia, and C.-C. Chu, "Empirical Research on the Relationship between Industry Working Capital Shortfall and Company Cash Holding in the Same Industry," *Discrete Dynamics in Nature and Society*, vol. 2022, Article ID 5146764, 14 pages, 2022.

Research Article

Empirical Research on the Relationship between Industry Working Capital Shortfall and Company Cash Holding in the Same Industry

Zhaohua Li,¹ Junyi Jiang,² Lijuan Xia ,³ and Chien-Chi Chu⁴

¹School of Accountancy, Harbin University of Commerce, Harbin 150028, China

²Center for Science Communication and Achievement Transformation, National Natural Science Foundation of China, Beijing 100085, China

³School of Economics and Management, Harbin Institute of Technology, Harbin 150001, China

⁴School of Economics and Management, Foshan University, Guangdong, 528000, China

Correspondence should be addressed to Lijuan Xia; lijuanx@163.com

Received 21 November 2021; Revised 12 December 2021; Accepted 19 January 2022; Published 23 February 2022

Academic Editor: Wenyao Zhang

Copyright © 2022 Zhaohua Li et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Affected by the fluctuation of the market and economic environment during the epidemic period, the capital pressure of companies has increased sharply, which increases the possibility of risk transmission in the same industry and poses new challenges to the operation and financing of companies. From the perspective of preventive motivation of corporate cash holding, we creatively use the industry working capital shortfall as the explanatory variable to construct an Extended Cash Holding Model and a Cash Holding Value Regression Model. Taking the panel data of A-share listed companies in Shanghai and Shenzhen as samples, this paper uses the Classical Linear Regression Model and Fixed Effects Regression Model to study the relationship between industry working capital shortfall and cash holdings in the same industry, as well as the relationship between industry working capital shortfall and cash holding value. The empirical results show that industry working capital shortfall has an important impact on the cash holding level within the same industry, and the cash holding level is significantly and positively correlated with industry working capital shortfall. Moreover, this study also reveals that the industry working capital shortfall has a dual impact on cash holdings. Specifically, the higher the risk of industry working capital shortfall, the lower the value of company cash holdings. The conclusions of this paper not only extend the research on cash holding but also provide support and reference for companies to optimize the cash holding value.

1. Introduction

The epidemic outbreak in 2019 spread all over the world. Policies, such as staying at home and maintaining social distance, have created new challenges to the global economy. Oxford Economics predicts that the impact of the epidemic will lead to the lowest growth rate of the global economy this year since the 2008 financial crisis. Simultaneously, due to the restrictions on production and operation during the epidemic, the daily operation of companies is abnormal and the capital turnover is difficult. Capital holdings have become a decisive source of capitals to support the operation of companies. For instance, once the revenue exceeded 100

million, the ITXDL listed on the new third board failed to resist the break of the capital chain caused by the epidemic and went bankrupt. Cash is an important economic resource in business operation, and a large number of empirical research studies have indicated that listed corporations prefer substantial cash holdings regardless of the countries [1, 2]. Sufficient cash holding not only meets the company's day-to-day operations such as paying wages, purchasing raw materials, and paying interests but also plays a critical role in the company's investment, financing decisions, dividend payout policy, dealing with emergencies, and so on. Thus, "cash is king" is gradually accepted by financial managers. Especially after the outbreak of the global economic crisis in

2008, all social sectors are more concerned about cash holdings. The collapse of Lehman Brothers and Chrysler have demonstrated the importance of cash assets to the company. In this paper, the cash holding level is the company's cash and cash equivalents. The cash holding value is measured by the excess return of the difference between the company's annual return and the average market return of the total market value.

The world economy has gradually recovered from the international financial crisis in 2008. One experience learned from the global economic crisis in 2008 is that the capital shortfall in an industry may cause serious negative externalities, as Brownlees and Engle documented that capital shortfall of large financial institutions will weaken their functions and have adverse effects on the economy [3], and Zheng and Song revealed that the stock market crisis will cause more damage on the system [4]. The industry, as the external environment most closely related to companies, has a direct and significant impact on the operation of the enterprise in the industry [5]. Problems in the industry, such as industry capital shortfall, not only limit the development of the entire industry but also affect the profits of companies in the industry. Therefore, the industry capital is also closely concerned by the company and its investors. Now, under the outbreak of novel coronavirus pneumonia, the companies' cash holding once again becomes the decisive factor for the development of companies. Demary et al. found that similar to the pattern observed after the financial crisis, companies affected by the COVID-19 will strengthen capital corporate saving to better cope with future shocks [6]. Some scholars proposed that companies with abundant cash holdings can buffer against the outbreak of the COVID-19 epidemic [7], and Wiczorek-Kosmala took the tourism industry as an example and proved the importance of cash holding in resisting risks [8].

Considering the impact of emergencies on enterprises, it has extraordinarily practical significance to study cash holding of companies under crisis, which is helpful for companies to solve the emergency quickly and effectively. However, the cash holding level, the amount of cash held by a company, is a double-edged sword for the company. Oler and Picconi pointed out that the deviation of cash holdings from the optimal level, i.e., exceeding the optimal level and insufficient cash holdings, has adverse effects on the income of companies [9]. On the one hand, excessive cash holdings may trigger a high level of idle funds, which can further cause higher opportunity costs for the company. On the other hand, insufficient cash holdings may cause loss of investment opportunities, unaffordable business expense, and increase in financing cost. Brealey et al. also pointed out that one of the most important research issues in the financial sector is the determination of company's cash holdings [10]. Thakur and Kannadhasan further confirmed the increase of cash holdings will increase the value of companies but also may cause greater corruption [11]. The above research shows that the value of cash holdings of companies is variant and affected by many factors, for instance, quality of corporate governance and corporate financial policy, etc. This reflects that the real value of cash

holding value under specific circumstances is an important aspect that companies need to consider when making cash holding decisions. Therefore, it is urgent to investigate relevant factors that may affect cash holding level and cash holding value. In terms of the industry working capital shortfall, we wonder that how will the industry working capital shortfall affect the cash holding level in the same industry corporations? Furthermore, how will the working capital shortfall affect the value of cash holdings in the same industry?

Since the 1990s, a myriad of research has studied the decision-making of cash holding. Both theoretical and empirical research have yielded fruitful results. There are several mature theoretical models, and these theories can be divided into two broad categories: capital structure theories and agency conflict theories. First, the capital structure theories also include trade-off theory [12] and pecking-order theory [13]. The main characteristics of trade-off theory are to determine the financing structure of a company by weighing costs and benefits. Different from the trade-off theory, pecking-order theory determines the factors that affect cash holding level and value from the information asymmetry perspective. The second category theory is agency conflicts, in which there are four types: flexibility hypothesis [14], spending hypothesis [15], shareholder power hypothesis [16, 17], and costly contracting theory [18]. The research on the influence of agency conflict on corporate decision making is widely used. Agency conflict theory is applied to study the complex relationship between directors and managers in corporate governance [19]. Risk management based on agency conflict proposes that the methods commonly used to motivate managers exacerbate the institutional challenges associated with risk [20]. Besides, in terms of taxation, Tang et al. using conflict theory explored the role of local government. Empirical research mainly focuses on two aspects [21]. One aspect is the factors that affect the cash of companies (see Harford et al. [22] and Chen et al. [23]). The other research aspect is the influence of cash holdings on economic consequences (see Denis and Sibilkov [24] and Almeida et al. [25]). However, most studies are explored based on the developed capital market environment and corporate governance environment. The applicability of these conclusions in Chinese listed companies needs to be further verified. In particular, China is in the economic transition period, where the level of corporate governance in China is relatively low, and the capital market is inadequate.

As far as we know, there is no formal study to explore the relationship between cash holdings and working capital shortfall in China's market environment. Therefore, it is of great significance to study how the industry working capital shortfall affects cash holdings from the perspective of industry characteristics and market environment in China. The contribution of this study is threefold.

First, we introduce working capital shortfall to study cash holdings in the same industry which enriches the existing research results related to cash holdings and provides empirical support for cash holding theory based on precautionary motivation. According to the motivation of

cash holding, most of the existing research studies on cash holding are from the transaction motivation, while the research from the perspective of precautionary is still limited. Consequently, inspired by the study of Opler et al. [27] and Faulkender and Wang [26], we research the impact of working capital shortfall about the cash holdings within the same industry under the background of financial crisis based on the theory of precautionary motivation of cash holdings.

Second, this study enriches the research results of cash holding value and provides a new insight into the economic consequences caused by the industry working capital shortfall. This study considers industry working capital shortfall in the same industry as a new research perspective and illustrates the impact of working capital shortfall on cash holding value from agency theory, which also enriches the research results of agency theory. More importantly, based on the economic consequences caused by the shortfall of working capital in the same industry, the research conclusions of this paper can also guide managers to make scientific cash holding decisions.

Third, the development of the companies in the same industry has certain common characters. This study provides support for cash holding decisions by companies in the same industry, especially in the major emergency prevention motivation. Industries and companies are closely linked, and the development of companies largely depends on industry trends. The bankruptcy of a company cannot be absorbed by more powerful competitors when the industry is in recession or economic recession, which may release more negative signals to the market and even affect the stability of the overall market economy. Therefore, the research of this paper can provide a decision-making reference for the management of the industry and the overall economy.

To better clarify the research problem, the rest of this paper is organized as follows. The reminder of this paper begins with a description review of cash holding in Section 2. Section 3 puts forward the research hypothesis. Section 4 presents the data used for the empirical and provides a detailed description of the model. Section 5 discusses the empirical results and conducts the robustness test. Section 6 outlines our conclusions and managerial implications.

2. Related Work

This paper is mainly related to two streams of literature: influencing factors of cash holding literature and cash holding value research literature. The first stream focuses on studying the influence factor of cash holdings and is presented in studies by Isshaq et al. [28] and Ozkan and Ozkan [29]. These studies are based on listed companies in developed countries and investigated internal factors that influence the level of cash holdings. These findings suggest that the cash holding level is positively related to these factors including company growth, cash flow, and information asymmetry degree and is negatively related these factors including financial expertise of the board members, company size, credit rating, and debt level. After that, many studies have incorporated financing constraints into the analysis to study the impact of this variable on cash holdings,

and representative research included Almeida et al. [25], Arslan et al. [30], and Han and Qiu [31]. Furthermore, Duchin [32] and Subramaniam et al. [33] explored whether the organizational structure of firms affects the cash holdings. Lin investigated the structural factors that affect the cash holdings of listed companies from the perspective of ownership structure [34]. Al-Najjar looked into the impact of dividend policy and capital structure on cash holdings in developing countries [35]. Lim and Lee took Korean companies as an example to investigate how CEO characteristics affect corporate excess cash holdings [36]. Jebran et al. studied the effect of principal-principal conflicts on cash holdings [37]. Among this stream of literature, the following studies are related to ours because they examine the external factors that influence cash holdings. Chen and Chuang pointed out cash holdings of companies depend on the external environment, that is, with the increase of external investment opportunities, companies will increase their cash holdings, and effective corporate governance can promote companies to increase cash holdings [38]. Bugshan et al. firstly explored the relationship between Shariah compliance and corporate cash holdings, as well as the adjustment speed of the optimal cash holding target of trade-off theory [39]. Baum et al. empirically studied the relationship between the macroeconomic volatility and the current asset allocation of non-financial companies [40]. Similarly, Abushammala and Sulaiman further identified the macroeconomic factors that affect corporate cash holdings through empirical research [41]. Taking emerging markets as the research object, Feng et al. further confirmed the increase of policy uncertainty, and the companies' value with more cash holdings is greater [42]. Using a "quasi natural experiment," Doidge and Dyck studied the interactions between tax incentives and corporate policies and found that the company's cash holding policy is adjusted with changes in tax incentives [43]. Magerakis et al. also documented that the tax regime significantly affects the cash holdings of UK corporation [44]. In addition, Gill and Shah discussed in detail the internal and external factors that determine the capital holding of Canadian companies [45]. To deal with the impact of accidents on companies, Qin et al. studied the impact of COVID-19 on enterprise cash holdings by difference-in-differences method and found that COVID-19 has a significant positive impact on industry cash holdings in serious-impact industries [7]. Based on the data of 285 listed companies in Vietnam, Nguyen et al. found that cash holdings had a positive impact on financial stability during the pandemic crisis [46]. The essential difference between this stream of literature and our work is that we incorporate the industry working capital shortfall into the determinants of cash holdings and explore how this factor affects the company's cash holdings.

The second related stream of the literature concentrates on cash holding value, including studies by Denis and Sibilkov [24], Louis et al. [47], Huang et al. [48], and Schauten et al. [49]. Drobetz and Grüninger [50], Bugshan et al. [39], and Kusnadi [51] proposed that the quality of corporate governance has a positive role in promoting cash market value. Tong investigated how corporate

diversification affects corporate cash holding value. The author documented that with low level of corporate governance in companies, diversification hurts cash value among firms [52]. Aktas et al. considered CEO behavior and showed that the effect of CEO overconfidence on cash holding value depends on the enterprise financial situation [53]. Some studies also documented that the existence of liquidity constraints also helps to improve the cash value. For example, Denis and Sibilkov [24] pointed out that the cash holding value of financially constrained companies is higher than that of unconstrained companies. Almeida et al. [25] also proved that the financially constrained company is more valuable than the financially unconstrained company.

The marginal value of cash was first proposed by Faulkender and Wang [27]. They took stock excess return as the research object and found that the cash marginal value is negatively correlated with the cash holding level. Chou and Feng further discussed how multiple directorships affect the value of cash held by companies and found that the increase of multiple directors will limit the cash holdings and increase the marginal value of cash holdings [54]. Kusnadi studied how political connections influence the cash holdings [55]. Compared with the companies without vertical interlock, Chen and Yang proved that investors tend to value cash holdings in companies with vertical interlock substantially less [56]. Ahmadi et al. studied the effect of product competition and growth opportunity on the cash holding value [57]. Pinkowitz et al. further investigated investment protection policies in different countries [58]. Breuer et al. considered the degree of investors' risk aversion and then proved that the cash holding value decreases with the aversion of investors to information uncertainty [59]. Bharadwaj et al. discussed the cash holdings of companies based on the brand value [60]. Mikkelsen and Partch proposed that high cash holdings contribute to the improvement of operating performance [61]. Martínez-Sola et al. documented a concave relation between cash holdings and firm value, verifying the existence of an optimum level of cash holding [62]. Different from these studies above, we analyze cash holdings by incorporating the industry working capital shortfall and further investigate the influence of industry working capital shortfall on the cash holdings.

3. Research Hypotheses

Compared with previous studies, this study not only considers the influence of internal variables on the cash holdings but also introduces an external variable of "industry working capital shortfall" to study cash holdings. This paper defines cash holding level as money and cash equivalents of a company. The cash holding value is defined as the excess return between the company's annual return and the average market return of the total market value. According to the previous section, it is reasonable to adopt working capital shortfall to examine the relationship between cash holdings and working capital shortfall.

First, the research of cash holding level and cash holding value has made considerable achievements from the perspective of the company's features, such as financial

behaviors, governance features, and financial constraints. The external environment is also one of the crucial factors that affect the company's cash holdings, such as the macroeconomic factors, degree of economic prosperity, degree of market competition, and so on. Therefore, the influence of external environment factors on cash holdings should be further discussed. However, the existing research on the external environmental factors of cash holdings mainly focuses on macroeconomic factors. Quantifying macroeconomic factors is a challenge, and the quantitative results may not be accurate and cannot be analyzed. So, we choose industry working capital shortfall as an external environment factor to study its impact on cash holdings.

Second, previous studies have laid a solid theoretical and model foundation for the research of this paper. We take Opler et al.'s model [26] as our baseline model and analyze the relationship between industry working capital shortfall and cash holdings. Then, we use the model of the marginal value of cash proposed by Chen et al. [23] to explore the relationship between industry working capital shortfall and the cash holding value. In addition to the model, the variable of industry working capital shortfall used by the two models can be measured based on the idea of value at risk. Industry working capital shortfall is defined as the 95 percentile of working capital gap ratio of all companies in the same industry over the last five years. Specifically, industries are classified according to the Guidelines for Industry Classification of Listed Companies issued by China in 2012 in this paper.

Combining the above analysis and the research questions in this paper, how will the industry working capital shortfall affect the cash holdings in the same industry corporations? Furthermore, how will the working capital shortfall affect the value of cash holdings in the same industry? The following sections analyze the above problems in detail and form two research hypotheses.

The Impact of the Working Capital Shortfall on the Level of Cash Holdings in the Same Industry. The company's investment activities, such as new product development, will be hindered by the shortage of working capitals. Some of the company's objects, such as customer satisfaction, market share, and economic benefit, will also be implicitly affected by the working capitals in the same industry. A succession of events may eventually cause the company to close or even go bankrupt. Jensen and Meckling had indicated that cash works as a buffer against the disadvantage of a liquidity shortage [63]. Therefore, companies can cope with potential working capital shortfall problem through changing the number of cash holdings. Considering the similarity and convergence of companies within the same industry, the company can prevent the shortfall risk based on the reference companies which have already fallen into the working capital shortfall problem.

Hypothesis 1: under the control of other factors, the working capital shortfall is positively correlated with the cash holding level of companies within the same industry. That is, the greater the working capitals shortfall, the more the cash holdings of companies within the same industry.

The Impact of the Working Capital Shortfall on the Value of Cash Holdings of Corporations within the Same Industry. Based on Hypothesis 1, when the shortfall in working capital is large, firms tend to hold more cash. Liu and Mauer pointed out that cash holdings can effectively avoid the shortage and help to get a positive evaluation of the capital market [18]. The ways to increase cash holdings of listed companies in China mainly include two means which are internal financing and external financing, respectively. On the one hand, the industry shortage of working capital has squeezed the profit margin of the companies in the industry. The decline in profits makes it difficult for companies to increase cash holdings through internal financing and rely on external financing to increase capital holdings. On the other hand, the information asymmetry phenomenon is apparent in China's capital market. Besides, investors are pessimistic about the development of the industry due to the shortfall of working capital, which has been proven by Pinkowitz et al. [58]. These reasons have led to very high external financing cost. Based on the above analysis, this study proposes the following hypothesis.

Hypothesis 2: the industry working capital shortfall is negatively correlated with the cash holding value of corporations within the same industry. That is, the greater the shortfall of working capitals, the lower the cash holding value of corporations within the same industry.

4. Empirical Design

4.1. Data Sources and Sample Selection. Demary et al. proposed that the pattern of companies during COVID-19 was similar to that observed after the financial crisis [6]. Considering the similarity between the epidemic and the 2008 financial crisis, this paper chooses Shanghai and Shenzhen A-share listed corporations from 2007 to 2015 as the initial samples, which can provide some reference for enterprise capital holding decisions under the epidemic situation. The financial data were collected from the Wind database. The corporate governance data were derived from the CSMAR database of GTA Information Technology Co. Ltd.

This paper used the following principles to collect and preprocess the data samples. (1) Financial listed corporations are excluded because their business characteristics are not suitable for our study. (2) All ST and *ST corporations are excluded because the long-term downturn caused by such corporations may lead to frequent changes in cash holdings. (3) Sample corporations in case of missing values are excluded. (4) In this paper, we use the winsorization method to deal with outliers. Sample companies with financial value deviating from the 1% quantile (99% quantile) are set as 1% quantile (99% quantile). According to these sampling criteria, 7775 company samples were obtained. The empirical research was conducted using STATA12.0 software.

4.2. Empirical Model. Following Opler et al. [26], we use working capital shortfall to test the hypothesis between the working capital shortfall and the cash holding level of a

company within the same industry; the empirical model is designed. Specifically, the model is represented as follows:

$$\begin{aligned} \text{cashhold}_{i,t} = & \beta_0 + \beta_1 \text{shortfall}_{i,t} + \beta_3 \text{nwc}_{i,t} + \beta_4 \text{leverage}_{i,t} \\ & + \beta_5 \text{size}_{i,t} + \beta_6 \text{tobing}_{i,t} + \beta_7 \text{dividend}_{i,t}, \\ & + \beta_8 \text{ce}_{i,t} + \beta_9 \text{cflow}_{i,t} + \beta_{10} \text{dbstr}_{i,t} + \beta_{11} \text{nei}_{i,t} \\ & + \beta_{12} \text{first}_{i,t} + \beta_{13} \text{dir}_{i,t} + \beta_{14} \text{idir}_{i,t} + \beta_{15} \text{jjr}_{i,t}, \\ & + \beta_{16} \text{liangzhi}_{i,t} + \varepsilon_{i,t}, \end{aligned} \quad (1)$$

where β_0 is a constant term, β_1 represent the regression coefficients of each variable, $\varepsilon_{i,t}$ is a random disturbance term, i denotes the i -th sample observation among the samples, and t represents time dimension. In this model, the explained variable is the corporate cash holding level ($\text{cashhold}_{i,t}$). The explanatory variable is the industry working capital shortfall ($\text{shortfall}_{i,t}$). The rest of the variables are set as control variables; the detailed description of these variables is listed in Part A of Table 1.

There are two widely used methods to measure the value of cash holdings: one is the Classic Company Value Regression Model proposed by Fama and French [64], and the other is the Marginal Value Regression Model proposed by Faulkender and Wang [27]. The Classical Value Regression Model reflects the marginal value of cash by analyzing the relationship between cash holdings and the change in cash and the company's market value, that is, cash holdings and change in cash are independent variables, and the corporate market value is the dependent variable in the regression model. However, the disadvantage of this method is that it is difficult to explain the regression coefficients of the variables obtained in the model. The Marginal Value Regression Model reflects the marginal value of cash by analyzing the relationship between the change in cash and the excess return of the company. This regression model is more intuitive in response to the cash compared with the Classical Value Regression Model. Therefore, we adopted the Marginal Value Regression Model to test the hypotheses between the cash holding value and the working capital shortfall. Specifically, the model is designed as follows:

$$\begin{aligned} r_{i,t} - R_{i,t}^B = & r_0 + r_1 \left(\frac{\Delta C_{i,t}}{M_{i,t-1}} \right) + r_2 (\text{shortfall}_{i,t}) \\ & + r_3 \left(\text{shortfall}_{i,t} * \frac{\Delta C_{i,t}}{M_{i,t-1}} \right) + r_4 \left(\frac{\Delta E_{i,t}}{M_{i,t-1}} \right) \\ & + r_5 \left(\frac{\Delta NA_{i,t}}{M_{i,t-1}} \right) + r_6 \left(\frac{\Delta I_{i,t}}{M_{i,t-1}} \right), \\ & + r_7 \left(\frac{C_{i,t-1}}{M_{i,t-1}} \right) + r_8 \left(\frac{NF_{i,t}}{M_{i,t-1}} \right) + r_9 (L_{i,t}) + \varepsilon_{i,t}, \end{aligned} \quad (2)$$

where r_0 is a constant term, r_i represent estimated parameters, and $\varepsilon_{i,t}$ is a random disturbance term. The explanatory variable is excess return ($r_{i,t} - R_{i,t}^B$). The model introduces two explanatory variables (one variable is the

TABLE 1: Variable name, symbol, and definition.

Variable name	Symbol	Variable definitions
Part A: effect variables of the cash holding levels		
Cash holding level	cashhold _{<i>i,t</i>}	Money and cash equivalents of company <i>i</i> in year <i>t</i> /year-end total assets in year <i>t</i>
95% quantile of industry working capital gap ratio	shortfall _{<i>i,t</i>}	From year <i>t-5</i> to year <i>t-1</i> , the 95% quantile of the working capitals gap ratio of the same industry, where the working capitals gap ratio is defined as max [0, -EBIT/total assets]
Fixed assets	fa _{<i>i,t</i>}	Year-end fixed assets of company <i>i</i> in year <i>t</i> /year-end total assets in year <i>t</i>
Net-working capitals	nwc _{<i>i,t</i>}	Net working capitals of company <i>i</i> in year <i>t</i> /year-end total assets in year <i>t</i>
Financial leverage	leverage _{<i>i,t</i>}	Total liabilities of company <i>i</i> in year <i>t</i> /total assets in year <i>t</i>
Corporation scale	size _{<i>i,t</i>}	Log (total assets) of company <i>i</i> in year <i>t</i>
Growth opportunities	tobing _{<i>i,t</i>}	Asset market value of company <i>i</i> in year <i>t</i> /asset book value in year <i>t</i> , asset market value = total liabilities + non-tradable shares * net assets per share (bps) + circulating a shares * per market price
Dividend payout	dividend _{<i>i,t</i>}	Ordinary dividends paid by company <i>i</i> in year <i>t</i> /total assets of company <i>i</i> in year <i>t</i>
Capital expenditure	ce _{<i>i,t</i>}	(Cash received from fixed assets, intangible assets, and other long-term assets-cash received from disposal of fixed assets, intangible assets, and other long-term assets)/year-end total assets in year <i>t</i>
Cash flow	cflow _{<i>i,t</i>}	(Net profit + depreciation, amortization) of company <i>i</i> in year <i>t</i> /year-end total assets in year <i>t</i>
Debt structure	dbstr _{<i>i,t</i>}	Current liabilities of company <i>i</i> in year <i>t</i> /total liabilities in year <i>t</i>
Net share issue dumb variable	nei _{<i>i,t</i>}	Company <i>i</i> in year <i>t</i> : if an IPO occurs, the value of rationed shares is 1; otherwise, it is 0
Equity concentration	first _{<i>i,t</i>}	The largest shareholder shareholding ratio of company <i>i</i> in year <i>t</i>
Board size	dir _{<i>i,r</i>}	Log (number of directors) company <i>i</i> in year <i>t</i>
Independent board size	<i>i di r_{i,r}</i>	Company <i>i</i> in year <i>t</i> : number of independent directors/number of directors
The size of the supervisory board	<i>jir_{i,r}</i>	Company <i>i</i> in year <i>t</i> : log (number of supervisors)
Two jobs are also dummy variables	liangzhi _{<i>i,t</i>}	Company <i>i</i> in year <i>t</i> : if the chairman or the manager is a concurrent post, the value is 1; otherwise, the value is 0
Part B: effect variables of the cash holding value		
Excess return	$r_{i,t} - R_{i,t}$	$r_{i,t}$ represents the annual return of company <i>i</i> in year <i>t</i> , $R_{i,t}$ represents the average market return of total market capitalization of company <i>i</i> in year <i>t</i>
Change in cash holdings	$\Delta C_{i,t}/M_{i,t-1}$	Company <i>i</i> in year <i>t</i> : change in cash holdings/equity market capitalization
95% quantile of the working capital gap	shortfall _{<i>i,t</i>}	From year <i>t-5</i> to year <i>t-1</i> , the 95% quantile of the working capitals gap ratio of the same industry , where the working capitals gap ratio is defined as max [0, - EBIT/total assets]
Change in earnings	$\Delta E_{i,t}/M_{i,t-1}$	Earnings before interest and tax of company <i>i</i> in year <i>t</i> /equity market capitalization in year <i>t-1</i>
Change in non-cash asset	$\Delta NA_{i,t}/M_{i,t-1}$	Change in non-cash assets (total assets - cash holdings) of company <i>i</i> in year <i>t</i> /equity market capitalization in year <i>t-1</i>
Change in financial expenses	$\Delta I_{i,t}/M_{i,t-1}$	Changes in financial expenses of company <i>i</i> in year <i>t</i> /equity market capitalization in year <i>t-1</i>
Cash holdings of last year	$C_{i,t-1}/M_{i,t-1}$	Cash holdings of company <i>i</i> in year <i>t-1</i> /equity market capitalization in year <i>t-1</i>
Net cash flow	$NF_{i,t}/M_{i,t-1}$	Net cash flow of financing activities of company <i>i</i> in year <i>t</i> /equity market capitalization in year <i>t-1</i>
Asset-liability ratio	$L_{i,t}$	Total liabilities of company <i>i</i> in year <i>t</i> /equity market capitalization in year <i>t</i>

Note. Indicators of Part B (except $L_{i,t}$ and $shortfall_{i,t}$) are divided by $M_{i,t-1}$ to eliminate the impact of corporation size on the model.

industry working capital shortfall ($shortfall_{i,t}$), and the other variable is the product of the working capital shortfall and the change in cash holdings ($shortfall_{i,t} * \Delta C_{i,t}$) to test the effect of the working capital shortfall and the cash holdings on excess returns of the company. For the meaning of other variables, see Part B in Table 1. To facilitate analysis, we derive the derivative of the two sides of formula (2), and then the cash holding value V becomes

$$V = r_1 + r_3 shortfall_{i,t}. \quad (3)$$

5. Empirical Results and Discussion

5.1. Descriptive Statistical Analysis. Table 2 lists the descriptive statistical results of the variables used in the models.

These results include the mean, standard deviation, minimum, median, and maximum of these variables. As can be seen from the statistical results in Panel A of Table 2, the mean value of cash holding level is 19.85%, indicating that cash is an important component of the company's total assets. The maximum of cash holdings is 69.23%, the minimum is only 1.49%, and the standard deviation is 14.45%, indicating that the gap between the cash holdings held by different corporations is great. The mean value of the working capital shortfall is 2.59%, which indicates that over the past five years, 5% of companies in the same industry have had a liquidity shortfall that exceeded the average level. The maximum of working capital shortfall is 19.37%, indicating that certain corporations may face huge working capital shortfall at times. The mean value of cash flow in the

TABLE 2: Descriptive statistics of the main variables.

Variable	N	Average	Standard deviation	Minimum value	Median	Maximum
Part A: variables that affect the level of cash holdings						
cashhold	8153	0.1985	0.1445	0.0149	0.1559	0.6923
shortfall	9300	0.0259	0.0344	0	0.0023	0.1937
size	8153	21.9285	1.2542	19.4698	21.7587	25.7218
leverage	8153	0.4281	0.2065	0.0873	0.4308	0.9720
tobing	8153	2.6463	2.0060	0.8711	1.9771	12.1996
cflow	8151	0.0618	0.0495	-0.1031	0.0578	0.2183
ce	8098	0.0531	0.0488	0.00018	0.0392	0.226
mwc	8151	0.193	0.181	-0.362	0.197	0.627
fa	8147	0.263	0.181	0.00218	0.231	0.756
dividend	8153	0.0122	0.0160	0	0.00687	0.0835
dbstr	8153	0.833	0.172	0.274	0.892	1
nei	9300	0.228	0.419	0	0	1
first	9300	0.355	0.151	0.0893	0.336	0.752
dir	8888	2.161	0.193	1.609	2.197	2.708
idir	8888	0.371	0.0537	0.300	0.333	0.571
jir	8888	1.256	0.255	1.099	1.099	1.946
liangzhi	8832	0.266	0.442	0	0	1
Part B: variables that affect the value of cash holdings						
$r_t - R_t$	8131	0.133	0.502	-1.683	-0.0221	4.198
$\Delta C_t/M_{t-1}$	5729	0.0378	0.260	-1.532	0.0093	1.382
shortfall _t	6790	0.0263	0.352	0	0.00193	0.194
$\Delta E_t/M_{t-1}$	5729	0.0127	0.061	-1.287	0.0637	2.544
$\Delta NA_t/M_{t-1}$	5729	0.149	0.628	-2.906	0.087	13.791
$\Delta I_t/M_{t-1}$	5729	0.00273	0.0177	-0.652	0.0036	0.674
C_{t-1}/M_{t-1}	6790	0.1825	0.192	0.0002	0.312	2.886
NF_t/M_{t-1}	5686	0.0896	0.146	-0.669	0.0548	3.103
L_t	8153	0.360	0.380	0.0037	0.395	0.983

Note. ① The counts N of each variable are different because each variable has different missing values. ②The counts N of Part A and Part B are different because the variables of Part B are the amount of changes per variable, indicating that the sample statistics are one year less than Panel A.

total assets is 6.18%, which is greater than the median value; its statistical result is similar to the cash holding variable. The mean of the financial leverage is 42.81%, and the median is 43.08%, indicating that the distribution of financial is similar to the normal distribution. In corporate governance variables, the mean value of ownership concentration is 35.5%, and the median is 33.6%, indicating that the shares of listed corporations in China are more concentrated. The average size of the board is 2.161. The average proportion of independent directors is 37.1%, and the average size of the board of supervisors is 1.256, indicating that the board of directors and supervisors is relatively small in Chinese listed companies.

The descriptive statistical results listed in Panel B of Table 2 are variables that affect the cash holding value. The maximum of excess returns ($r_{i,t} - R_{i,t}^B$) is 4.198. The minimum is 1.683. Also, the standard deviation is 0.502. The statistical results indicate that the excess returns of different companies are different and unstable. On the other hand, it also shows the instability of A-share market. The mean value of cash holding level ($C_{i,t-1}/M_{i,t-1}$) is 0.1825. The minimum and maximum are 0.002 and 2.886, respectively. They indicate that the level of cash holdings is high in China, and there a big gap in cash holding level between different listed corporations. These results also illustrate that listed corporations in China may have serious agency problems. The maximum of cash holdings ($\Delta C_{i,t}/M_{i,t-1}$) is 1.382. The

minimum is -1.532. The mean value is 0.0378. So, the gap between maximum and minimum in cash holding change is very large. The maximum and minimum of revenue changes ($\Delta E_{i,t}/M_{i,t-1}$) are 2.544 and -1.287, respectively, indicating that there is a distinct difference in profitability between listed corporations. The mean of change in non-cash assets ($\Delta NA_{i,t}/M_{i,t-1}$) is 0.129. The maximum and the minimum are 13.791 and 2.906, respectively, so the gap between the maximum in non-cash assets and the minimum in non-cash assets is large, which may be due to the different characteristics between the industries, and the average of the asset-liability ratio ($L_{i,t}$) is 0.36. The median is 0.395. Also, its distribution is similar to the normal distribution. But the maximum and minimum are 0.983 and 0.0037, respectively, indicating that different companies' financial leverage is different.

5.2. Correlation Analysis. Pearson and Spearman correlation coefficients are effective methods to evaluate multicollinearity [65, 66]. To avoid the effect of multicollinearity between variables on the experimental results, in this paper, Pearson and Spearman correlation coefficients are used to test the multicollinearity between variables. The results are shown in Table 3. Generally speaking, there is multicollinearity problem between variables if the correlation coefficient is more than 0.8. From Table 3, we can see that the

TABLE 3: Test of correlation coefficients of major variables (Pearson and Spearman).

Part A: variables that affect the level of cash holdings									
	cashhold	size	leverage	tobing	cflow	ce	nwc	fa	dividend
cashhold									
size	-0.268***								
leverage	-0.049***	-0.037***							
tobing	0.213***	-0.470***	0.026***						
cflow	0.223***	-0.037***	0.023***	0.228***					
ce	-0.038***	-0.074***	0.068***	-0.001	0.180***				
nwc	-0.187***	-0.087***	0.067***	-0.047***	-0.090***	-0.160***			
fa	-0.357***	0.104***	-0.116***	-0.175***	0.024**	0.442***	-0.377***		
dividend	0.301***	-0.072***	0.034***	0.112***	0.474***	0.110***	-0.002	-0.057***	
dbstr	0.212***	-0.317***	0.014**	0.160***	0.082***	-0.114***	0.075***	-0.249***	0.113***
shortfall	0.127***	0.063**	-0.097***	-0.004	-0.106*	-0.035***	-0.044**	0.064***	-0.141***
nei	0.063***	0.017**	0.015**	0.159***	0.047***	0.015*	0.026**	-0.054***	-0.074***
first	0.017**	0.256***	-0.043***	-0.126***	0.090***	0.002	-0.016	0.057***	0.108***
dir	0.074***	0.278***	-0.131***	-0.168***	-0.002	0.037***	-0.103***	0.149***	0.008
idir	0.030***	0.033***	0.032***	0.060***	-0.020*	-0.018	0.020*	-0.054***	-0.018
jir	-0.132***	0.288***	-0.163***	-0.016***	-0.038***	-0.045***	-0.129***	0.159***	-0.086***
liangzhi	0.126***	-0.194***	0.150***	0.116***	0.035***	0.096***	0.098***	-0.075***	0.076***
Continuation of part A									
	dbstr	shortfall	nei	first	dir	idir	jir	liangzhi	
cashhold	0.255***	0.187***	0.052***	0.015**	0.068***	0.030***	-0.120***	0.119***	
size	-0.345***	0.102***	0.076**	0.222***	0.266***	-0.004***	0.276***	-0.203***	
leverage	0.025***	-0.161***	0.031**	-0.064***	-0.156***	0.020***	-0.022***	0.176***	
tobing	0.251***	-0.084***	0.124***	-0.154***	-0.199***	0.031***	-0.230***	0.163***	
cflow	0.106***	-0.098***	0.019***	0.078***	-0.004	-0.019*	-0.057***	0.055***	
ce	-0.093***	-0.029***	0.018*	0.011	0.044***	-0.026	-0.046***	0.101***	
nwc	0.085***	-0.049***	-0.003**	-0.030	-0.096***	0.022*	-0.135***	0.104***	
fa	-0.202***	0.112***	-0.044***	0.045***	0.127***	-0.053***	0.126***	-0.050***	
dividend	0.109***	-0.178***	-0.096***	0.105***	0.014	-0.018	-0.091***	0.087***	
dbstr		-0.138***	-0.017	-0.030***	-0.112***	-0.007	-0.170***	0.109***	
shortfall	-0.110***		-0.016***	0.042	0.028	0.012**	0.092***	-0.055***	
nei	0.016	-0.039***		-0.062***	-0.012**	0.014*	-0.009***	0.012**	
first	-0.047***	0.006	-0.044***		0.003**	0.023***	0.047***	-0.045***	
dir	-0.122***	-0.002	-0.025**	0.027**		-0.448***	0.287***	-0.168***	
idir	-0.010	0.021**	0.008*	0.041***	-0.459***		-0.078**	0.088**	
jir	-0.165***	0.067***	-0.028**	0.060***	0.307***	-0.098***		-0.181***	
liangzhi	0.108***	-0.064***	0.024**	-0.059***	-0.160***	0.100***	-0.178***		
Part B: variables that affect the value of cash holdings									
	$r_t - R_t$	shortfall	$\Delta C_t/M_{t-1}$	$\Delta E_t/M_{t-1}$	$\Delta NA_t/M_{t-1}$	$\Delta I_t/M_{t-1}$	C_{t-1}/M_{t-1}	NF_t/M_{t-1}	L_t
$r_t - R_t$									
shortfall	-0.131**								
$\Delta C_t/M_{t-1}$	0.103***	0.026***							
$\Delta E_t/M_{t-1}$	0.217***	-0.022***	0.207***						
$\Delta NA_t/M_{t-1}$	0.162***	-0.116***	0.021**	0.311***					
$\Delta I_t/M_{t-1}$	-0.331**	0.171***	0.123***	0.091***	0.252***				
C_{t-1}/M_{t-1}	0.066***	-0.237***	-0.231***	0.134***	0.163***	-0.004***			
NF_t/M_{t-1}	-0.108***	0.108***	0.329***	0.149**	0.517***	0.247***	-0.053***		
L_t	-0.158***	0.170***	0.182***	0.032***	0.163***	0.168**	0.079***	0.142***	

Note: The Pearson coefficient is down the diagonal, and the spearman coefficient is above the diagonal. ***, **, *, respectively represent significant, 0.01, 0.05, 0.10 level.

correlation coefficients between variables are mostly less than 0.5 and are significant at the 0.1% level, indicating that there is no obvious multicollinearity problem between variables. There is a significant positive correlation between the industrial operating capital shortfall ($shortfall_t$) and cash holding level ($cashhold_t$) at the level of 1%; this result is consistent with Hypothesis 1. Also, there is a significant negative correlation between the industrial operating shortfall ($shortfall_t$) and returns ($r_t - R_t$) at the 1% level. This

result indicates that the shortage of working capitals may reduce the company's excess returns, thereby weakening the value of the company cash holdings.

5.3. Regression Fitting Results and Analysis. To test Hypothesis 1, this paper chooses the OLS Model, the Fixed Effect Model, and Random Effect Model to fit the corporate cash holding level with the explanatory variables, and the

results are shown in Table 4. Then, the Hausman test (Hausman test: a method used in the regression analysis of panel data, is applied to the regression of Fixed Effect Model and Random Effect Model Regression) is carried out to test the Fixed Effect Model and Random Effect Model. The test results show that the Random Effect Model is rejected by the test, so the regression results of the Fixed Effect Model and OLS Model are adopted for further use.

From Table 4, the adjusted R square of OLS Regression and Fixed Effect Regression is 0.2531 and 0.2687, respectively. Tested by OLS Regression and Fixed Effect Regression, the model has good reliability, and the coefficients are significant. The significance of the regression coefficient indicates that the design of the model is reasonable. By observing the regression results of each variable, the positive correlation between industrial operating capital shortfall ($shortfall_t$) and cash holdings ($cashhold_t$) in OLS and Fixed Effect Models is significant at the level of 0.1%. The result indicates that when the shortage of industrial operating capitals becomes more serious, companies in the same industry tend to hold more cash. From an economic point of view, assuming that other conditions remain unchanged, if there is a standard error (0.0344) change in working capital shortfall, then the proportion of cash holdings in total assets will change by 9.29% (Fixed Effect Model: $0.0344 * 0.27 = 0.00929$). The change in working capital shortfall is equivalent to an increase of 4.68% in the average value of cash holdings. That is, managers are particularly sensitive to the working capital shortfall within five years of other companies in the same industry. Thus, managers incline to hold more cash to deal with the possible shortage of working capitals. Thus, Hypothesis 1 has been supported. For other control variables, the corporation size, financial leverage, net operating capital ratio, and fixed asset ratio are negatively related to cash holdings, and the negative correlations are significant at the level of 0.1%. But the board size is significant at 1% level. The growth opportunities, stock issuance dummy variables, dividend dividends, and the largest shareholder holdings are positively correlated with cash holdings, and the positive correlations are significant at the level of 0.1%. But there is no obvious correlation between the scale of the independent director and corporate cash holdings. This result indicates that the small size of the independent directors' board in China results in weak decision execution over cash holdings.

To test Hypothesis 2, two types of data samples are regressed using the Fixed Effect Model based on considering the individual effects, and the two datasets are data samples considering working capital shortfall and data samples without considering working capital shortfall, respectively. The results are shown in Table 5. In Fixed Effect Regression I, the coefficient of change in cash holding variable ($\Delta C_t/M_{t-1}$) is 0.741, and the results of significance test indicate that cash holding increment has positive effect on excess returns significantly at the level of 0.1%, that is, each additional unit of input cash yields 0.741 unit of excess returns. The operating capital shortfall ($shortfall_t$) and the product of operating capital shortfall and the change in cash holding ($shortfall_t * \Delta C_t/M_{t-1}$) are added to Fixed Effect Regression

II to test the hypothesis. The coefficient of $shortfall_t$ is -1.192 , and the result indicates that operating capital shortfall has negative correlation on excess returns significantly at the level of 0.1%. The coefficient of $shortfall_{i,t} * \Delta C_{i,t}/M_{i,t-1}$ is -6.147 , and the result indicates that $shortfall_{i,t} * \Delta C_{i,t}/M_{i,t-1}$ has negative correlation on excess returns significantly at the level of 0.1%. The results show that both of them are negatively correlated with the excess returns, and the greater the gap of operating capitals shortfall, the lower the excess returns of cash. To investigate the relationship of cash holding value and operating capital shortfall more clearly, formula (3) ($V = r_1 + r_3 shortfall_{i,t}$) is also examined. From regression II, we can estimate the cash holding value in the case of a working capital shortfall. Assuming that the average value of working capital shortfall is 0.0263, we can calculate that the cash holding value of the company is 0.61 ($0.773 - 0.0263 * 6.147$) in the case of a working capital shortfall. In regression model I, formula (3) is used when the working capital shortfall is not considered; we can calculate that the cash holding value of the company is 0.74 ($0.741 - 0.0263 * 0$). These two regression results show that the cash holding value of listed companies in China is less than the face value. Furthermore, the shortage of working capital further reduces the value of cash holdings, so Hypothesis 2 is validated.

5.4. Robustness Test. To verify the validity of the above empirical study results and enhance the reliability of the results, we perform the following stability test.

Robustness Test 1. The Ordinary Least Square (OLS) Method is used to test the impact of operating capital shortfall on cash holding level in the same industry. To overcome the effect of heteroscedasticity and intra-group residual correlations on the estimation results, we conduct the OLS regression analysis under two conditions, respectively. In the first condition, we perform robust processing of the standard deviation to minimize the heteroscedasticity and residual correlation effect; then, we conduct OLS regression analysis. In the second condition, following Faulkender and Wang [27], we group companies according to their dividend payout ratio and then the OLS regression analysis is conducted after the clustering of companies. As shown in Table 6, the operating capital shortfall expands with the increase of cash holdings in the next year, and the positive relation is significant at the level of 0.1%. This result indicates that the relationship between the operating capital shortfall and the cash holding level is robust. The greater the gap of the operating capital shortfall in the industry is, the more cash the corporations in the same industry tend to hold, and the result is consistent with the empirical results.

Robustness Test 2. The OLS regression analysis of excess return is also conducted under two kinds of robustness test. The test results are shown in Table 7. The coefficient of $shortfall_t$ is -1.263 . The coefficient of $shortfall_{i,t} * \Delta C_{i,t}/M_{i,t-1}$ is -6.218 , and they are all significantly negatively correlated at 0.1%. According to formula

TABLE 4: The regression result of validating Hypothesis 1.

Model variables	OLS cashhold _t	Fixed effect regression cashhold _t	Random effect regression cashhold _t
shortfall _t	0.227*** (5.08)	0.270*** (8.61)	0.206*** (6.39)
size _t	-0.00144*** (-7.17)	-0.00126*** (-12.95)	-0.00220** (-2.93)
leverage _t	-0.0146*** (-19.84)	-0.0130*** (-26.33)	-0.0141*** (-35.15)
tobing _t	0.00678*** (6.05)	0.00870*** (11.39)	0.00898*** (14.14)
cflow _t	0.0961* (2.48)	0.0825* (2.55)	0.0874 (0.69)
ce _t	-0.0106** (-3.21)	-0.0172* (-2.11)	-0.0261 (-1.57)
nwc _t	-0.412*** (-21.87)	-0.491*** (-45.79)***	-0.400*** (-49.17)
fa _t	-0.368*** (-27.08)	-0.499*** (-37.10)	-0.445*** (-45.07)
nei _t	0.0195*** (5.92)	0.0207*** (8.87)	0.0201*** (9.03)
dividend _t	0.433*** (7.26)	0.394*** (6.61)	0.578*** (7.50)
dbstr _t	-0.0191** (-3.11)	-0.0215*** (-5.73)	-0.0223** (-2.97)
first _t	0.0490*** (3.92)	0.0380*** (8.94)	0.0931*** (8.44)
dir _t	0.0368** (3.15)	0.0383** (3.23)	0.0462* (2.15)
idir _t	-0.0677 (-1.87)	-0.0441 (-1.91)	0.0785 (1.99)
jir _t	-0.000986 (-0.50)	-0.000921 (-0.72)	-0.000344 (-0.44)
liangzhi _t	0.0132** (3.13)	0.0178** (3.29)	0.0159** (3.25)
cons	1.404*** (7.23)	1.304*** (15.30)	0.600*** (12.56)
F statistic	127.93***	163.49***	
Adj_R-sq	0.2531	0.2687	0.2717
Observation	7775	7775	7775

Note. The numbers in parentheses are *t*-test values; ***, **, and *, respectively, represent significance at 0.1%, 1%, and 5% levels. The random effect regression in STATA software does not give the F statistic, and it does not affect the study because it does not consider the random effect regression results. The bold values signify the main result.

TABLE 5: The regression result of validating Hypothesis 2.

Model Variable	Fixed effect regression I $r_t - R_t$	Fixed effect regression II $r_t - R_t$
$\Delta C_t/M_{t-1}$	0.741*** (16.62)	0.773*** (15.10)
$\Delta E_t/M_{t-1}$	1.993*** (24.76)	2.298*** (22.39)
$\Delta NA_t/M_{t-1}$	0.0295** (3.46)	0.0103*** (6.78)
$\Delta I_t/M_{t-1}$	-7.309*** (-46.46)	-6.327*** (-40.46)
C_{t-1}/M_{t-1}	0.338** (3.25)	0.131* (2.81)
NF_t/M_{t-1}	-0.156* (-2.46)	-0.213 (-1.40)

TABLE 5: Continued.

Model Variable	Fixed effect regression I $r_t - R_t$	Fixed effect regression II $r_t - R_t$
L_t	-0.4844*** (-19.48)	-0.4158*** (-14.53)
shortfall _t		-1.192*** (-36.55)
shortfall _t * $\Delta C_t/M_{t-1}$		-6.147*** (-12.16)
cons	0.0615*** (7.58)	0.0647*** (6.01)
F statistic	103.59***	83.79***
Adj_R-sq	0.2426	0.2192
Observation	5677	5677

Note. The numbers in parentheses are *t*-test values; ***, **, and *, respectively, represent significance at 0.1%, 1%, and 5% levels. The bold values signify the important results explained in the text.

TABLE 6: Results of robustness test 1.

Model Variable	OLS with robust cashhold _t	OLS with cluster cashhold _t
shortfall _t	0.227*** (6.22)	0.227*** (7.42)
size _t	-0.00144*** (-8.55)	-0.00144*** (-5.51)
leverage _t	-0.0146*** (-5.21)	-0.0146*** (-13.04)
tobing _t	0.00678*** (7.53)	0.00678** (2.95)
cflow _t	0.0961* (2.13)	0.0961* (2.33)
ce _t	-0.0106** (-3.28)	-0.0106* (-2.41)
nwc _t	-0.412*** (-23.63)	-0.412*** (-16.56)
fa _t	-0.368*** (-24.50)	-0.368*** (-20.26)
nei _t	0.0195*** (6.76)	0.0195*** (5.20)
dividend _t	0.433*** (7.32)	0.433*** (4.87)
dbstr _t	-0.0191* (-2.48)	-0.0191** (-3.09)
first _t	0.0490* (2.56)	0.0490* (2.12)
dir _t	0.0368* (2.16)	0.0368** (3.21)
idir _t	-0.0677 (-1.93)	-0.0677 (-1.23)
jiir _t	-0.000986 (-0.48)	-0.000986 (-0.34)
liangzhi _t	0.0132* (2.34)	0.0132* (2.19)
cons	1.404*** (9.77)	1.404*** (6.51)
F statistic	134.92***	129.70***
Adj_R-sq	0.2531	0.2531
Observation	7775	7775

Note. The numbers in parentheses are *t*-test values; ***, **, and *, respectively, represent significance at 0.1%, 1%, and 5% levels.

TABLE 7: Results of robustness test 2.

Model Variable	OLS with cluster $r_t - R_t$	OLS with robust $r_t - R_t$
$\Delta C_t/M_{t-1}$	0.751*** (6.06)	0.751*** (5.16)
$\Delta E_t/M_{t-1}$	2.192** (3.75)	2.192*** (21.34)
$\Delta NA_t/M_{t-1}$	0.0111** (3.31)	0.0111* (2.45)
$\Delta I_t/M_{t-1}$	-6.364*** (-4.24)	-6.364*** (-5.34)
C_{t-1}/M_{t-1}	0.134** (3.51)	0.134** (3.24)
NF_t/M_{t-1}	-0.201 (-0.10)	-0.201 (-0.68)
L_t	-0.4249** (-3.47)	-0.4249*** (-6.43)
shortfall _t	-1.263*** (6.15)	-1.263** (-3.52)
shortfall _t * $\Delta C_t/M_{t-1}$	-6.218*** (-20.84)	-6.218*** (-17.36)
cons	0.0591*** (-11.87)	0.0591*** (-8.96)
F statistic	123.19***	105.04***
Adj_R-sq	0.2297	0.2297
Observation	5677	5677

Note. The numbers in parentheses are *t*-test values; ***, **, and *, respectively, represent significance at 0.1%, 1%, and 5% levels. The bold values signify the main result.

(3), the greater the working capital shortfall, the lower the cash holding value of corporations in the same industry, and this finding is consistent with the above research results which indicate that the regression result is robust.

6. Conclusions and Managerial Implications

Inspired by the impact of major emergencies on enterprise operation, the aim of this paper is to provide empirical evidence for the relationship between industry working capital shortfall and cash holdings. We constructed an

Extended Cash Holding Model and a Cash Holding Value Regression Model by introducing the industry working capital shortfall as one of the explanatory variables. To study the impact of major emergencies on corporate cash holdings, this paper selects the 2007–2015 panel data after the financial crisis for empirical analysis. A Classical Linear Regression Model and Fixed Effects Regression Model are adopted to explore the impact of industry working capital shortfall on the level and value of cash holdings in the same industry, which reveals the relationship between working capital shortfall and cash holdings.

Different from the existing research results, the major contribution of this paper is to study the effect of industry working capital shortfall on cash holdings of the company. This analysis shows that there is a two sides effect relation between industry working capital shortfall and cash holdings, which implies that industry working capital shortfall is a crucial factor in the determination of cash holdings, especially in case of emergency. The larger the working capital shortfall, the more cash companies in the same industry hold. Meanwhile, the cash holding value of companies within the same industry is depressed due to the shortage of industry working capitals. This is, the working capital shortfall is not only the incentive factor of cash holdings but also the restraining factor of cash holding value. As the working capital shortfall has a dual impact on cash holdings, it is necessary to weigh the working capital shortfall and cash holdings in order to maximize value. This result is also robust to heteroscedasticity test and residual correlation test, respectively.

For companies, the interruption of cash flow is the most fatal factor that directly leads to bankruptcy. Since the outbreak of the COVID-19, due to some social emergency strategies, market imbalance, and other reasons, the operation of some companies has been seriously shocked, which results in an increased risk of capital shortfall. From the perspective of preventive motivation of corporate cash holding, this paper provides direct empirical evidence for companies to deal with crisis events and provides a theoretical basis for companies to make decisions on cash holdings under the influence of major and emergency events. Meanwhile, it also enriches the relevant research on cash holding with preventive motivation. Our research has several implications for managers and industry working capital shortage research. First, the current epidemic situation is still severe. Based on the important buffer role of cash holding in crisis, managers should increase their cash holdings decisions to fully deal with possible risks. Second, due to the “two sides effect” of industry working capital shortfall on the level and value of cash holdings in the same industry, it is not always beneficial for companies to increase their cash holdings during the epidemic. Thus, companies should weigh the relationship between industry working capital shortfall, cash holding level, and cash holding value, so as to resist risks and maximize enterprise value. Finally, to cope with the impact of major events, such as the financial crisis and epidemic on the economy, the government can stabilize the market environment by regulating the industry working capital.

This research is based on the data of Chinese listed companies, and the conclusions drawn are applicable to Chinese market. However, the applicability of this conclusion in other countries needs to be further verified. In addition, as the epidemic continues, relevant data affected by COVID-19 continue to be enriched. In the future, we can consider updating the sample data and exploring more direct evidence [63].

Data Availability

The financial data were collected from the Wind database. The corporate governance data were derived from the CSMAR database of GTA Information Technology Co. Ltd.

Disclosure

Zhaohua Li and Junyi Jiang are Co-first author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This study was supported by the National Natural Science Foundation of China under grant no. 71771041.

References

- [1] A. Dittmar, J. Mahrt-Smith, and H. Servaes, “International corporate governance and corporate cash holdings,” *Journal of Financial and Quantitative Analysis*, vol. 38, no. 1, pp. 111–133, 2003.
- [2] T. W. Bates, K. M. Kahle, and R. M. Stulz, “Why do U.S. Firms hold so much more cash than they used to?” *The Journal of Finance*, vol. 64, no. 5, pp. 1985–2021, 2009.
- [3] C. Brownlees and R. F. Engle, “SRISK: a conditional capital shortfall measure of systemic risk,” *Review of Financial Studies*, vol. 30, no. 1, pp. 48–79, 2017.
- [4] Q. Zheng and L. Song, “Dynamic contagion of systemic risks on global main equity markets based on Granger causality networks,” *Discrete Dynamics in Nature and Society*, vol. 2018, Article ID 9461870, 13 pages, 2018.
- [5] C. Gasparotti, “The internal and external environment analysis of Romanian naval industry with SWOT model,” *Management & Marketing Journal*, vol. 4, no. 3, pp. 97–110, 2009.
- [6] M. Demary, S. Hasenclever, and M. Hüther, “Why the COVID-19 pandemic could increase the corporate saving trend in the long run,” *Intereconomics*, vol. 56, no. 1, pp. 40–44, 2021.
- [7] X. Qin, G. Huang, H. Shen, and M. Fu, “COVID-19 pandemic and firm-level cash holding-moderating effect of goodwill and goodwill impairment,” *Emerging Markets Finance and Trade*, vol. 56, no. 10, pp. 2243–2258, 2020.
- [8] M. Wiczorek-Kosmala, “A study of the tourism industry’s cash-driven resilience capabilities for responding to the COVID-19 shock,” *Tourism Management*, vol. 88, Article ID 104396, 2022.
- [9] D. K. Oler and M. P. Picconi, “Implications of insufficient and excess cash for future performance,” *Contemporary Accounting Research*, vol. 31, no. 1, pp. 253–283, 2009.

- [10] R. A. Brealey, S. C. Myers, F. Allen, and P. Mohanty, *Principles of Corporate Finance*, Tata McGraw-Hill Education, New York, USA, 2012.
- [11] B. P. S. Thakur and M. Kannadhasan, "Corruption and cash holdings: evidence from emerging market economies," *Emerging Markets Review*, vol. 38, pp. 1–17, 2019.
- [12] F. Modigliani and M. H. Miller, "Corporate income taxes and the cost of capital: a correction," *The American Economic Review*, vol. 53, no. 3, pp. 433–443, 1963.
- [13] S. C. Myers and N. S. Majluf, "Corporate financing and investment decisions when firms have information that investors do not have," *Journal of Financial Economics*, vol. 13, no. 2, pp. 187–221, 1984.
- [14] M. C. Jensen, "Agency costs of free cash flow, corporate finance, and takeovers," *The American Economic Review*, vol. 76, no. 2, pp. 323–329, 1986.
- [15] M. C. Jensen and W. H. Meckling, "Theory of the firm: managerial behavior, agency costs and ownership structure," *Journal of Financial Economics*, vol. 3, no. 4, pp. 305–360, 1976.
- [16] J. Harford, S. A. Mansi, and W. F. Maxwell, "Corporate governance and firm cash holdings in the US," *Journal of Financial Economics*, vol. 87, no. 3, pp. 535–555, 2008.
- [17] T.-H. Kuan, C.-S. Li, and S.-H. Chu, "Cash holdings and corporate governance in family-controlled firms," *Journal of Business Research*, vol. 64, no. 7, pp. 757–764, 2011.
- [18] Y. Liu and D. C. Mauer, "Corporate cash holdings and CEO compensation incentives," *Journal of Financial Economics*, vol. 102, no. 1, pp. 183–198, 2011.
- [19] J. T. Campbell, T. C. Campbell, D. G. Sirmon, L. Bierman, and C. S. Tuggle, "Shareholder influence over director nomination via proxy access: implications for agency conflict and stakeholder value," *Strategic Management Journal*, vol. 33, no. 12, pp. 1431–1451, 2012.
- [20] T. A. Gormley and D. A. Matsa, "Playing it safe? Managerial preferences, risk, and agency conflicts," *Journal of Financial Economics*, vol. 122, no. 3, pp. 431–455, 2016.
- [21] T. Tang, P. L. L. Mo, and K. H. Chan, "Tax collector or tax avoider? An investigation of intergovernmental agency conflicts," *The Accounting Review*, vol. 92, no. 2, pp. 247–270, 2017.
- [22] J. Harford, S. Klasa, and W. F. Maxwell, "Refinancing risk and cash holdings," *The Journal of Finance*, vol. 69, no. 3, pp. 975–1012, 2014.
- [23] Y. Chen, P. Y. Dou, S. G. Rhee, C. Truong, and M. Veeraraghavan, "National culture and corporate cash holdings around the world," *Journal of Banking & Finance*, vol. 50, pp. 1–18, 2015.
- [24] D. J. Denis and V. Sibilkov, "Financial constraints, investment, and the value of cash holdings," *Review of Financial Studies*, vol. 23, no. 1, pp. 247–269, 2010.
- [25] H. Almeida, M. Campello, and M. S. Weisbach, "The cash flow sensitivity of cash," *The Journal of Finance*, vol. 59, no. 4, pp. 1777–1804, 2004.
- [26] M. Faulkender and R. Wang, "Corporate financial policy and the value of cash," *The Journal of Finance*, vol. 61, no. 4, pp. 1957–1990, 2006.
- [27] T. Opler, L. Pinkowitz, R. Stulz, and R. Williamson, "The determinants and implications of corporate cash holdings," *Journal of Financial Economics*, vol. 52, no. 1, pp. 3–46, 1999.
- [28] Z. Isshaq, G. A. Bokpin, and J. Mensah Onumah, "Corporate governance, ownership structure, cash holdings, and firm value on the Ghana Stock Exchange," *The Journal of Risk Finance*, vol. 10, no. 5, pp. 488–499, 2009.
- [29] A. Ozkan and N. Ozkan, "Corporate cash holdings: an empirical investigation of UK companies," *Journal of Banking & Finance*, vol. 28, no. 9, pp. 2103–2134, 2004.
- [30] O. Arslan, C. Florackis, and A. Ozkan, "The role of cash holdings in reducing investment-cash flow sensitivity: evidence from a financial crisis period in an emerging market," *Emerging Markets Review*, vol. 7, no. 4, pp. 320–338, 2006.
- [31] S. Han and J. Qiu, "Corporate precautionary cash holdings," *Journal of Corporate Finance*, vol. 13, no. 1, pp. 43–57, 2007.
- [32] R. Duchin, "Cash holdings and corporate diversification," *The Journal of Finance*, vol. 65, no. 3, pp. 955–992, 2010.
- [33] V. Subramaniam, T. T. Tang, H. Yue, and X. Zhou, "Firm structure and corporate cash holdings," *Journal of Corporate Finance*, vol. 17, no. 3, pp. 759–773, 2011.
- [34] C. Lin, "Research on the influencing factors of cash holdings of listed companies—based on the perspective of dual principal-agent theory," *Open Journal of Social Sciences*, vol. 8, no. 6, pp. 369–386, 2020.
- [35] B. Al-Najjar, "The financial determinants of corporate cash holdings: evidence from some emerging markets," *International Business Review*, vol. 22, no. 1, pp. 77–88, 2013.
- [36] J. Lim and S. C. Lee, "Relationship between the characteristics of CEOs and excess cash holdings of firms," *Emerging Markets Finance and Trade*, vol. 55, no. 5, pp. 1069–1090, 2019.
- [37] K. Jebran, S. Chen, and M. Z. Tauni, "Principal-principal conflicts and corporate cash holdings: evidence from China," *Research in International Business and Finance*, vol. 49, pp. 55–70, 2019.
- [38] Y.-R. Chen and W.-T. Chuang, "Alignment or entrenchment? Corporate governance and cash holdings in growing firms," *Journal of Business Research*, vol. 62, no. 11, pp. 1200–1206, 2009.
- [39] A. Bugshan, F. Alnori, and W. Bakry, "Shariah compliance and corporate cash holdings," *Research in International Business and Finance*, vol. 56, Article ID 101383, 2021.
- [40] C. F. Baum, M. Caglayan, N. Ozkan, and O. Talavera, "The impact of macroeconomic uncertainty on non-financial firms' demand for liquidity," *Review of Financial Economics*, vol. 15, no. 4, pp. 289–304, 2006.
- [41] S. N. Abushammala and J. Sulaiman, "Impact of macroeconomic performance on corporate cash holdings: some evidences from Jordan," *Asian Economic and Financial Review*, vol. 4, no. 10, p. 1363, 2014.
- [42] X. Feng, Y. L. Lo, and K. C. Chan, "Impact of economic policy uncertainty on cash holdings: firm-level evidence from an emerging market," *Asia-Pacific Journal of Accounting & Economics*, pp. 1–23, 2019.
- [43] C. Doidge and A. Dyck, "Taxes and corporate policies: evidence from a quasi natural experiment," *The Journal of Finance*, vol. 70, no. 1, pp. 45–89, 2015.
- [44] E. Magerakis, C. Siriopoulos, and A. Tsagkanos, "Cash holdings and firm characteristics: evidence from UK market," *Journal of Risk & Control*, vol. 2, no. 1, pp. 19–43, 2015.
- [45] A. Gill and C. Shah, "Determinants of corporate cash holdings: evidence from Canada," *International Journal of Economics and Finance*, vol. 4, no. 1, p. 70, 2012.
- [46] C. K. Nguyen, A. Q. Nguyen, N. Q. Nguyen, T. T. M. Nguyen, A. N. Chu, and L. T. M. Nguyen, "Cash holding and financial stability during a crisis: a case study of Vietnamese firms in covid-19 pandemic," in *Forum for Social Economics*, pp. 1–14, Routledge, England, Uk, 2021.
- [47] H. Louis, A. X. Sun, and O. Urcan, "Value of cash holdings and accounting conservatism *," *Contemporary Accounting Research*, vol. 29, no. 4, pp. 1249–1271, 2012.

- [48] C. Huang, X. Ma, and Q. Lan, "An empirical study on listed company's value of cash holdings: an information asymmetry perspective," *Discrete Dynamics in Nature and Society*, vol. 2014, Article ID 897278, 12 pages, 2014.
- [49] M. B. Schauten, D. Van Dijk, and J. P. van der Waal, "Corporate governance and the value of excess cash holdings of large European firms," *European Financial Management*, vol. 19, no. 5, pp. 991–1016, 2013.
- [50] W. Drobetz and M. C. Grüniger, "Corporate cash holdings: evidence from Switzerland," *Financial Markets and Portfolio Management*, vol. 21, no. 3, pp. 293–324, 2007.
- [51] Y. Kusnadi, "Do corporate governance mechanisms matter for cash holdings and firm value?" *Pacific-Basin Finance Journal*, vol. 19, no. 5, pp. 554–570, 2011.
- [52] Z. Tong, "Firm diversification and the value of corporate cash holdings," *Journal of Corporate Finance*, vol. 17, no. 3, pp. 741–758, 2011.
- [53] N. Aktas, C. Louca, and D. Petmezas, "CEO overconfidence and the value of corporate cash holdings," *Journal of Corporate Finance*, vol. 54, pp. 85–106, 2019.
- [54] T.-K. Chou and H.-L. Feng, "Multiple directorships and the value of cash holdings," *Review of Quantitative Finance and Accounting*, vol. 53, no. 3, pp. 663–699, 2019.
- [55] Y. Kusnadi, "Political connections and the value of cash holdings," *Finance Research Letters*, vol. 30, pp. 96–102, 2019.
- [56] X. Chen and C. Yang, "Vertical interlock and the value of cash holdings," *Accounting and Finance*, vol. 61, no. 1, pp. 561–593, 2021.
- [57] S. A. Ahmadi, A. Soroushyar, and I. K. Branch, "Industry structure, growth opportunity and the value of cash holding," *International Business Management*, vol. 9, no. 6, pp. 1346–1351, 2015.
- [58] L. Pinkowitz, R. Stulz, and R. Williamson, "Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis," *The Journal of Finance*, vol. 61, no. 6, pp. 2725–2751, 2006.
- [59] W. Breuer, M. O. Rieger, and K. C. Soypak, "Corporate cash holdings and ambiguity aversion," *Review of Finance*, vol. 21, no. 5, pp. 1933–1974, 2016.
- [60] N. Bharadwaj, D. M. Hanssens, and R. K. Rao, "Corporate brand value and cash holdings," *Journal of Brand Management*, vol. 27, no. 2, pp. 1–13, 2020.
- [61] W. H. Mikkelsen and M. M. Partch, "Do persistent large cash reserves hinder performance?" *Journal of Financial and Quantitative Analysis*, vol. 38, no. 2, pp. 275–294, 2003.
- [62] C. Martínez-Sola, P. J. García-Teruel, and P. Martínez-Solano, "Corporate cash holding and firm value," *Applied Economics*, vol. 45, no. 2, pp. 161–170, 2013.
- [63] M. C. Jensen and W. H. Meckling, "Theory of the firm: managerial behavior, agency costs and ownership structure," *Journal of Financial Economics*, vol. 3, no. 4, pp. 305–360, 1976.
- [64] E. F. Fama and K. R. French, "Taxes, financing decisions, and firm value," *The Journal of Finance*, vol. 53, no. 3, pp. 819–843, 1998.
- [65] R. H. Franke, G. Hofstede, and M. H. Bond, "Cultural roots of economic performance: a research note," *Strategic Management Journal*, vol. 12, no. S1, pp. 165–173, 1991.
- [66] P. C. R. Barbosa, L. F. Tófoli, M. P. Bogenschutz et al., "Assessment of alcohol and tobacco use disorders among religious users of ayahuasca," *Frontiers in Psychiatry*, vol. 9, p. 136, 2018.