

Minh, Hung Phan Tran; Thi, Kim Nguyen; Be, Loan Pham Thi

## Article

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Cogent Business & Management

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*Suggested Citation:* Minh, Hung Phan Tran; Thi, Kim Nguyen; Be, Loan Pham Thi (2022) : The non-linear impact of financial leverage on cash holdings: Empirical evidence from Vietnam, Cogent Business & Management, ISSN 2331-1975, Taylor & Francis, Abingdon, Vol. 9, Iss. 1, pp. 1-22,  
<https://doi.org/10.1080/23311975.2022.2114304>

This Version is available at:

<https://hdl.handle.net/10419/289215>

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**To cite this article:** Hung Phan Tran Minh, Kim Nguyen Thi & Loan Pham Thi Be (2022) The non-linear impact of financial leverage on cash holdings: Empirical evidence from Vietnam, Cogent Business & Management, 9:1, 2114304, DOI: [10.1080/23311975.2022.2114304](https://doi.org/10.1080/23311975.2022.2114304)

**To link to this article:** <https://doi.org/10.1080/23311975.2022.2114304>



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Received: 22 April 2022  
Accepted: 14 August 2022

\*Corresponding author: Loan Pham Thi Be, Lecturer, University/Institution: University of Economics, the University of Danang, 71 Ngu Hanh Son, Bac My An Ward, Ngu Hanh Son District, Da Nang City, Vietnam  
Email: [loanptb@due.edu.vn](mailto:loanptb@due.edu.vn)

Reviewing editor:  
David McMillan, University of Stirling, Stirling, United Kingdom

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## BANKING & FINANCE | RESEARCH ARTICLE

# The non-linear impact of financial leverage on cash holdings: Empirical evidence from Vietnam

Hung Phan Tran Minh<sup>1</sup>, Kim Nguyen Thi<sup>1</sup> and Loan Pham Thi Be<sup>2\*</sup>

**Abstract:** This article examines the non-linear relationship between financial leverage and cash holdings in the emerging market context—Vietnam. We use the dynamic model with the system generalized method of moments (SGMM) estimator and the comprehensive data set of stocks listed on the Vietnamese stock market from 2007 to 2019. The database is collected from accounting data related to 513 Vietnamese firms' characteristics and provided by Fiin Pro. We indicate that financial leverage exerts a negative impact on cash holdings at low levels, but the relationship becomes positive at high levels of financial leverage. We further find that short-term and long-term debt are non-linearly related to cash holdings. Our findings offer implications for managers to operate their firms at different levels of financial leverage. Firms at low levels of financial leverage should tend to hold less cash and issue debt since the addition of debt to adapt investment and operation could maximize corporate value. In contrast, firms at high levels of financial leverage could hoard cash to mitigate the likelihood of financial distress, bankruptcy and to reserve borrowing capacity because such firms are more likely to experience financial distress and go bankrupt. Policymakers could draw up policies to reduce the likelihood of experiencing financial distress and bankruptcy, such as the decrease of the debt financing and the increase of the likelihood of equity financing.

**Subjects:** Finance; Business, Management and Accounting; Entrepreneurship and Small Business Management

**Keywords:** Vietnamese listed firms; financial leverage; cash holdings; non-linear relationship; dynamic models

## 1. Introduction

Cash holdings play an important role in the firm's balance sheet (Tong, 2011). Therefore, cash holding decisions have recently been a focus of attention in the corporate finance literature (e.g., Guney et al., 2007; Arora, 2019). Cash holding decisions are typically determined and influenced by three

## PUBLIC INTEREST STATEMENT

This article examines the non-linear relationship between financial leverage and cash holdings in the emerging market context—Vietnam. We use the dynamic model with the system generalized method of moments estimator and 513 Vietnamese firms' comprehensive data listed on the Vietnamese stock market from 2007 to 2019. We indicate that financial leverage exerts a negative impact on cash holdings at low levels, but the relationship becomes positive at high levels. We further find that short-term and long-term debt are non-linearly related to cash holdings. Firms at low levels of financial leverage should tend to hold less cash and issue debt, whereas firms at high levels of financial leverage could hoard cash to mitigate the likelihood of financial distress, bankruptcy and to reserve borrowing capacity. Policymakers could draw up policies such as decreasing debt financing and increasing the likelihood of equity financing to reduce the likelihood of experiencing financial distress and bankruptcy.

theoretical models, including the trade-off theory (Myers, 1977), the pecking order theory (Myers & Majluf, 1984) and the free cash flow theory (Jensen, 1986). From the complete theoretical framework, a separate but growing body of the literature has shed light on some important determinants of cash holdings. For example, Opler et al. (1999), Chen (2008), D'Mello et al. (2008), and Harford et al. (2008), and Bates et al. (2009) analyze the determinants of cash holdings for US firms. Ozkan and Ozkan (2004); Al-Najjar and Belghitar (2011) look at the UK firms to determine the determinants of cash holdings. Most empirical findings have devoted to indicating the important role of financial leverage in cash holding decisions. Particularly, the mixed theoretical predictions and the at least partly ambiguous empirical evidence is on the role played by financial leverage in cash holding decisions. For example, under the trade-off theory, highly levered firms allocate higher cash ratios (Al-Najjar & Belghitar, 2011; Arora, 2019; Kim et al., 2011; Martínez-Sola et al., 2018). In contrast, highly levered firms that tend to follow a hierarchy in their financing policies have low levels of cash reserves (Ferreira & Vilela, 2004). Furthermore, highly levered firms that suffer from the free cash flow problem store less cash balances (Ferreira & Vilela, 2004; Hardin et al., 2009; Opler et al., 1999).

In Vietnam, financial leverage and cash holdings issues are taken into account separately. Additionally, the linear relationship between financial leverage and cash holdings has also been considered. However, the existing empirical evidence is mixed. For example, Tran (2020) finds the positive relationship between financial leverage and cash holdings. In the meantime, Thu and Khuong (2018) and Khuong et al. (2020) show the negative effect of financial leverage on corporate cash holdings of the energy enterprises listed on Vietnam's stock market. Moreover, Nguyen and Nguyen (2021) find that financial leverage is negatively associated to cash holdings for non-financial listed firms in Vietnam. Non-linearity is based on linearity. Therefore, the ambiguous empirical evidence on the linear relationship is more likely to result in the mixed non-linear relationship. Until now, the empirical evidence on the curvilinear relationship between financial leverage and cash holdings in the Vietnamese market has not been provided.

Only limited attention has centered on the curvilinear relationship between financial leverage and cash holdings. Drobetz and Grüninger (2007) and Guney et al. (2007) are prominent to emphasize that financial leverage positively (negatively) related to cash holdings appears at low (high) levels of financial leverage and financial leverage negatively (positively) related to cash holdings exists at high (low) levels of financial leverage in the context of developed markets. Hall et al. (2014) look solely at 20 emerging markets to reach the similar conclusion as Drobetz and Grüninger (2007), Guney et al. (2007), Nenu and Vintila (2017), and Thanatawee (2019). find similar results in the context of Romania and Thailand, respectively. Therefore, Drobetz and Grüninger (2007), Guney et al. (2007), Hall et al. (2014), Nenu and Vintila (2017), and Thanatawee (2019). are closest in spirit to our study. However, it is naive to jump to the conclusion that the curvilinear relationship between financial leverage and cash holdings in Vietnam and other emerging markets are remarkably similar since the nature of the non-linear relation between financial leverage and cash balances seems to change from one country to another depending upon country-specific characteristics (Guney et al., 2007). Therefore, it is motivated to revisit the question of whether the curvilinear relationship between financial leverage and cash holdings exists in the context of an emerging market like Vietnam. To the best of our knowledge, we are the first to provide empirical evidence on the curvilinear relationship between financial leverage and cash holdings in the Vietnamese market.

Many specific factors could account for discrepancies in holding cash in emerging markets from that of developed markets. Examples of these are, namely, such institutional characteristics as cognitive, normative and regulative structures. These factors play a relevant role in determining firm's financial practices such as cash holdings (Scott, 1995) and conservative financial practices and are known as the consequence of slow institutional development (North, 2005). In addition, the socio-economic characteristics including laws and actor's attitudes are weak in many emerging markets relative to that in developed markets (North, 2005). This results in the increase in the level of uncertainty in transactions and consequently encourage a range of unproductive practices such as cash reserves (Al-Najjar, 2013).

The Vietnamese financial market is known as an emerging market. Hence, the market variation is large, mainly conditional on international financial markets and macroeconomic conditions. Consequently, the agency problem and asymmetric information become more pronounced in Vietnam where investor protection mechanism is weak compared to the developed countries (Huynh et al., 2020; Nguyen & Ramachandran, 2006; Vo, 2018). Moreover, the Vietnamese stock market is characterized as thin and infrequent trading in an inefficient and weak form (Loc et al., 2010). Additionally, the Vietnamese financial system is characterized by a bank-based system that Vietnamese listed firms tend to take advantage of an arm's length relationship with their lenders to use loans as the most important source of financing (Nguyen & Ramachandran, 2006). Furthermore, Demirgüç-Kunt and Maksimovic (1999) document that firms in emerging markets rely mostly on short-term debt and Vietnam is not exceptional. Accordingly, Vietnamese listed firms are heavily dependent on short-term debt rather than long-term debt (Le & Phan, 2017). Vietnam is also known as a typical emerging market that the investor protection is weakest in developing markets in the South-East Asian region (i.e. Indonesia, India, Malaysia, Thailand, Philippines and Vietnam) (World Bank, 2014)).

Some unique characteristics of the Vietnamese financial market may account for discrepancies in financial leverage and cash holding among markets. Furthermore, the existing empirical evidence reveals that the differences of legal, institutional and macroeconomic conditions may account for discrepancies in the financial leverage–cash holdings relationship among countries. For example, Ozkan and Ozkan (2004); Ferreira and Vilela (2004) document that the increase of financial leverage leads to a reduction in cash levels. Meanwhile, Guney et al. (2007) and Arora (2019) indicate that highly levered firms have a tendency to financial constraints, so that firms tend to hoard cash as a precautionary motive. It is more likely that the heterogeneity in the non-linear relationship between financial leverage and cash holdings exists among markets. Therefore, the most novel contribution lies in the use of the Vietnamese database of listed firms to again provide the empirical support for the curvilinear relationship between financial leverage and cash holdings in an emerging market. Vietnam was chosen so that theories could be tested and empirical evidence secured to allow for future research possibilities. Thus, the unique dimensions of Vietnamese listed firms have the potential to induce differences in the form of the curvilinear relationship between financial leverage and cash holdings, but this would require investigation to confirm so in this and future research.

The remainder of this paper is organized as follows: Section 2 describes the theoretical framework, empirical evidence, and the main hypothesis on the non-linearity between financial leverage and cash holdings. Data and methodology are discussed in Section 3. Section 4 reports our main empirical findings and a series of robustness tests. General discussions are found in Section 5. Section 6 concludes the paper.

## 2. Literature review and hypothesis development

The existing theoretical framework reveals three methodologies that support the financial leverage–cash holdings relationship. To exemplify, the trade-off theory posits that a firm can maximize its value by operating at an optimal level of cash reserves, which balances the marginal benefits against the costs of debt financing. Under the assumption, the main cost of holding cash is the opportunity cost of the capital invested in liquid assets. This cost is often called the cost-of-carry which means the difference between the earnings from holding cash and the interest that firms will pay to fund additional cash. The benefits of holding cash stems from two motives: transaction minimization and precautionary motives. In relation to the former, the main advantage of holding cash is that the firm saves transaction costs to raise funds and does not have to liquidate assets to make payments. Therefore, firms stockpile cash when the rising-costs and the opportunity costs of cash retention are greater. In relation to the latter, due to market issues such as available sources of funding or financing costs, a firm can use the liquid assets to finance its activities and investments (Dittmar et al., 2003). The pecking order theory reveals that firms follow a pecking order of financing to minimize costs related to information asymmetry. Accordingly, firms finance

investments first with retained earnings, then with safe debt and risky debt, and finally with equity. Extending this theory, firms use its liquid reserves before issuing debt when their investments exceed internally generated funds. In contrast, when the firm has internal surplus, it will pay down its debt. The free cash flow theory (Jensen, 1986) contends that entrenched managers have incentive to increase the resources under the management, to gain discretionary power over the firm investment decision and reduce the likelihood of monitoring by the capital markets. Therefore, cash holdings in excess of the required to fund all productive investments could lead to conflicts of interest between shareholders and managers over payout policies, since free cash flow provides managers more discretion and they can invest the excess of cash in unproductive investments or waste it.

According to the trade-off theory, highly levered firms are likely to experience financial distress and go into bankruptcy due to the pressure that rigid amortization plans put on the firm treasury management. Therefore, higher cash ratios are allocated to mitigate the likelihood of financial distress and reserves borrowing capacity (Al-Najjar & Belghitar, 2011; Arora, 2019; Kim et al., 2011; Martínez-Sola et al., 2018). In the meantime, pecking order and free cash flow theories indicate that firms with higher leverage should maintain less cash holdings. Therefore, high levels of financial leverage and low levels of cash reserves occur simultaneously when investment is greater than internally generated funds. The free cash flow theory (Jensen, 1986) contends that using cash flows to meet the requirements of debt servicing obligations is more likely to lead to a shortage of available resources, thereby reducing managers' power and increasing the likelihood of monitoring by the capital markets. However, low levered firms are subject to low investor scrutiny and high managerial discretion. Highly levered firms with low cash reserves are more likely to suffer from underinvestment problem (Myers, 1977) due to stockholder–bondholder agency conflicts. Consequently, highly levered firms with low cash reserves cannot raise funds and forgo productive investment opportunities, hence eroding firm value. As a consequence, low-levered firms are more likely to amass cash reserves since low-levered firms are not better monitored compared to high-levered firms. Furthermore, debt also can be used as a simple remedy to mitigate the free cash flow problem (Parrino & Weisbach, 1999) because the requirements of debt servicing obligations are well documented as a disciplinary device to limit managers' flexibility to use free cash flows and, in turn, on management's ability to amass cash. Therefore, leverage exerts a negative impact on cash holdings (Hardin et al., 2009). To the extent that highly levered firms that are more likely to be constrained in accessing external funds hoard cash as a precautionary motive.

Drobetz and Grüninger (2007), Guney et al. (2007), and Hall et al. (2014) are prominent to emphasize the non-monotonic nature of the financial leverage–cash holdings relationship. Specifically, Drobetz and Grüninger (2007) merely look at Swiss non-financial firms to reveal the nonlinear relationship between financial leverage and cash holdings with a U-shaped curve. Accordingly, financial leverage positively (negatively) related to cash holdings appears at low (high) levels of financial leverage and financial leverage negatively (positively) related to cash holdings exists at high (low) levels of financial leverage. Guney et al. (2007) reach the same conclusion in the international context. Hall et al. (2014) tell a similar story when taking firms in 20 emerging markets into account. Nenu and Vintila (2017) and Thanatawee (2019). find similar results in the context of Romania and Thailand, respectively.

The Vietnamese financial system is characterized by a bank-based system that Vietnamese-listed firms tend to take advantage of an arm's length relationship with their lenders to use loans as the most important source of financing (Nguyen & Ramachandran, 2006). As a consequence, Vietnamese-listed firms are generally over-levered. Accordingly, the addition of debt could not maximize corporate value since the costs of debt (e.g., financial distress and bankruptcy costs, stockholder–bondholder agency conflicts) overwhelm the benefits of debt (e.g., tax savings, mitigated manager–shareholder agency costs). Therefore, the addition of debt is served to adapt investment and operation rather than cash holdings. However, to the extent that financial leverage is higher, firms are likely to experience financial distress and go into bankruptcy. As

a consequence, allocating higher cash ratios is needed to mitigate the likelihood of financial distress and reserves borrowing capacity.

In the light of the existing theoretical and empirical evidence, we expect that financial leverage is negatively related to cash holdings appearing at low levels of financial leverage since financial leverage is more likely to serve as the ability to issue debt that plays an important role as a cash substitute. Financial leverage is positively related to cash holdings that exist at high levels of financial leverage since highly levered firms are likely to experience financial distress and go into bankruptcy and hence allocating higher cash ratios to mitigate the likelihood of financial distress and reserves borrowing capacity. Therefore, the following testable hypothesis is proposed: Financial leverage and cash holdings have a non-linear relationship (H1).

### 3. Methodology and data

#### 3.1. Empirical model

The static model assumes that firms operate in a “perfectly efficient market”; hence, firms can instantaneously adjust towards the target cash level. However, the nature of cash holdings is dynamic since firms adjust to their target cash holdings in the presence of adjustment costs. Accordingly, firms are based on the decisions in the past to make the current decisions of cash holdings (Ozkan & Ozkan, 2004). In other words, the dynamic model describes the dynamics of cash holdings and allows estimating the speed of adjustment towards an endogenously determined target cash ratio in the presence of adjustment costs. Empirically, the traditional specification to examine the determinants of cash holdings is static (Ferreira & Vilela, 2004; Guney et al., 2007). In the meantime, Ozkan and Ozkan (2004); Chen (2008); García-Teruel and Martínez-Solano (2008); Kim et al. (2011); Bigelli and Sánchez-Vidal (2012) use the dynamic model to examine the determinants of cash holdings. As a consequence, the non-linear relationship between financial leverage and cash holdings could not be fully reflected, even inducing misleading inferences in the static model. Therefore, we use the dynamic model to examine this economic relation. Accordingly, we include the first lag of cash holdings in our model as an explanatory variable to remove the serial correlation problem and act as a proxy for the status quo of cash holdings, representing the cumulative result of past decisions on financing choices over time.

To eliminate the channel through which endogeneity biases estimate causal effects due to the potential presence of reverse causality from the dependent variable’s impact on explanatory variables, all independent variables are the lagged variables (Bellemare et al., 2017). In other words, we only focus heavily on the influence of the square of financial leverage and on cash holdings but not vice versa (Guney et al., 2007).

Hence, we closely follow the theoretical framework and existing empirical evidence in financial leverage and cash holdings literature such as Drobetz and Grüninger (2007), Guney et al. (2007), Kim et al. (2011), and Bigelli and Sánchez-Vidal (2012) to model the non-linear relationship between corporate leverage and cash holdings as follows:

$$\text{CASH}_{i,t} = \beta_0 + \beta_1 \text{CASH}_{i,t-1} + \beta_2 \text{LEV}_{i,t-1} + \beta_3 \text{LEV}_{i,t-1}^2 + \beta_4 \text{CV}_{i,t-1} + \mu_i + \theta_{t-1} + u_{i,t-1} \quad (1)$$

where  $i$  indexes firms and  $t$  indicate the time period. CASH is the cash holdings. LEV is the financial leverage including both book and market values. CV represents control variables.  $\mu_i$  denotes time-invariant unobservable firm-fixed effects.  $\theta_{t-1}$  represents time-fixed effects that are time-variant and common to all firms.  $u_{i,t-1}$  is the time-varying disturbance term.

#### 3.2. Estimation method

The traditional econometric techniques, such as the OLS or fixed-effect (FE) estimators would lead to biased and inconsistent estimates for the dynamic panel data model since (i) the correlation between the firm-fixed effects and the dynamic term in the OLS estimator results in an omitted-

variable bias; (ii) the correlation of the transformed error term with the dynamic term results in a small sample bias (see Baltagi (2008) for a review). The bias becomes less severe if the number of time periods is relatively large. However, this bias remains for a sample with number of time periods up to 30 (Judson & Owen, 1999). To overcome this finite sample bias, Blundell and Bond (1998) propose the system generalized method of moments (SGMM) estimator. Accordingly, the estimator combines moment conditions of two simultaneous equations, including both difference and level equations, to overcome important dynamic effects and accounts for endogeneity in the explanatory variables. Specifically, lagged first-differenced instruments in the level equation and lagged-levels instruments in the first-difference transformation equation are incorporated into the instrument set under the assumption of “white noise” disturbances are inconsistent if the errors are autocorrelated. In order to ensure the validity of the SGMM estimator, the absence of second-order serial correlation and correlation between the instruments and the error term does exist. Generally, the earlier discussions on econometric techniques for the determinants of cash holdings in the dynamic model suggest that the SGMM estimator is the most appropriate method to regress this relationship. Empirically, Guariglia & Yang (2018); Guizani (2017) use the SGMM estimator to deal with inconsistencies and misleading inferences in the dynamic model for the issues relating cash holdings and financial leverage. Therefore, we use the SGMM estimator to explore the economic correlation mentioned above.

### 3.3. Variable construction

#### 3.3.1. Cash holdings

We follow the convention in the cash holding literature (e.g., Al-Najjar & Belghitar, 2011; Ferreira & Vilela, 2004; Martínez-Sola et al., 2018; Opler et al., 1999; Ozkan & Ozkan, 2004) to define cash holdings as the ratio of total cash and cash equivalents plus short-term investment to total asset. We also provide another definition of cash holdings as the ratio of total cash and cash equivalents plus short-term investment to total asset minus total cash and cash equivalents plus short-term investment. The definition of the dependent variables is shown in Table 1.

#### 3.3.2. Financial leverage

Using the book- or market-based measure of financial leverage is controversial. On the one hand, Fama and French (2002); Thies and Klock (1992) indicated that the book value was not influenced by factors which are indirectly controlled by firms. Besides, book value is given more priority in academic research due to less volatility over the time. This is restricted to the occurrence of extreme observations. On the other hand, the market value describes the fluctuation of financial leverage over time in detail. Welch (2004) also reveals that the market-based financial leverage could detail the relative ownership of the firm by lenders and shareholders.

Although the book debt ratio is preferred in academic research, it does not reflect the variation of debt ratios that stems from the volatility of the market. Therefore, following Fama and French (2002), Gaud et al. (2005), and Dang et al. (2019), we employ both book and market values to take advantage of the strength of each measure. Additionally, we adopt two alternative definitions of financial leverage to test for the robustness of our results. These detailed measures are described in Table 1.

#### 3.3.3. Control variables

To estimate the net influence of the squared financial leverage on cash holdings, we follow the convention in the cash holdings and financial leverage literature (e.g., Drobetz & Grüninger, 2007; García-Teruel & Martínez-Solano, 2008; Guney et al., 2007; Hall et al., 2014; Opler et al., 1999) and model control variables that appear regularly in the literature, including size, return on assets, liquidity, tangible assets, market-to-book, firm age. The definition of the control variables is shown in Table 1.



**Table 1. Variable definitions**

Variable	Acronym	Description
<b>A. Cash holdings</b>		
Cash holdings	<b>CASH1</b>	(Cash and cash equivalents + short-term investment)/Total assets
Cash holdings	<b>CASH2</b>	(Cash and cash equivalents + short-term investment)/(Total assets—cash and cash equivalents—short-term investment)
<b>B. Financial leverage</b>		
Book leverage	<b>BLEV</b>	The book value of total debt divided by the book value of the total assets.
Market leverage	<b>MLEV</b>	The book value of total debt divided by the sum of market value of equity and the book value of total debt.
<b>C. Control variables</b>		
Size	<b>SIZE</b>	The natural logarithm of total sales
Return on assets	<b>ROA</b>	The ratio of earnings after tax to total assets
Liquidity	<b>LIQ</b>	The current assets to current liabilities
Tangibility	<b>TANG</b>	The current assets to total assets
Market-to-book	<b>MB</b>	Market-to-book equity ratio
Sale growth	<b>SG</b>	The annual growth rate of total sales

### 3.4. Data

To test our hypothesis, our database is collected from accounting data related to firm characteristics and provided by Fiin Pro.<sup>1</sup> Our initial sample includes 705 listed firms on the Vietnamese stock market between 2007 and 2019. As Opler et al. (1999); Bigelli and Sánchez-Vidal (2012); Maheshwari and Rao (2017); Arora (2019), we exclude 78 financial firms and 45 utility firms due to some form of regulatory supervision or the nature of their business. Besides, due to the appearance of the lagged variables in the regression specification, for a firm to be included in our analysis using panel data models, we also require the firms to have data for all variables for at least two consecutive years to avoid bias in our regression results. Therefore, we eliminate 14 new listed stocks in 2019. We also exclude 55 firms with missing data. These screening procedures result in a final panel data sample of 513 firms, with 4,801 firm-year observations. All continuous variables are winsorized at the 1st and 99th percentiles to eliminate the influence of extreme observations.

## 4. Results

### 4.1. Descriptive statistics and correlations

Table 2 provides summary statistics for the entire sample. In our sample, an average firm has the CASH1 and CASH2 of 0.08 and 0.098, respectively. The medians of CASH1 and CASH2 are 0.053 and 0.056, respectively. The 10th percentile of CASH1 and CASH2 are both 0.008. Meanwhile, the 90th percentile of CASH1 and CASH2 are 0.191 and 0.237, respectively. These figures indicate that the absolute values of CASH2 are higher than these of CASH1 and that the standard deviation of CASH1 (0.083) is lower than that of CASH2 (0.123).

The mean (median) values of the book and market leverage are 0.535 (0.560) and 0.555 (0.583) respectively. Further, the 10th and 90th percentiles of BLEV are 0.239 and 0.794, while the 10th

**Table 2. Summary statistics**

STATS	N	Mean	SD	P10	P25	Median	P75	P90
CASH1	4,801	0.080	0.083	0.008	0.021	0.053	0.111	0.191
CASH2	4,801	0.098	0.123	0.008	0.022	0.056	0.125	0.237
BLEV	4,801	0.535	0.204	0.239	0.380	0.560	0.697	0.794
MLEV	4,801	0.555	0.246	0.196	0.360	0.583	0.766	0.869
SIZE	4,801	13.295	1.438	11.519	12.266	13.257	14.257	15.097
ROE	4,801	0.117	0.131	0.006	0.046	0.114	0.186	0.264
LIQ	4,801	1.134	0.960	0.383	0.566	0.861	1.329	2.156
TANG	4,801	0.209	0.185	0.025	0.069	0.154	0.298	0.480
MB	4,801	1.187	1.111	0.356	0.530	0.858	1.402	2.313
SG	4,801	0.154	0.318	-0.114	-0.024	0.082	0.242	0.487

Notes: CASH1 and CASH2 are the cash holdings; BLEV (MLEV) is the book (market) leverage; SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. The variable definitions are in [Table 1](#).

and 90th percentiles of MLEV are 0.196 and 0.869, respectively. These figures indicate that the standard deviation of the market leverage (0.246) is higher than that of the book leverage (0.204).

An average firm has the natural logarithm of total assets of 13.295 which is quite similar to the median (12.257). The mean and median values of the return on equity are 11.7% and 11.4%, respectively. This implies that the earnings ratio of Vietnamese listed firms is relatively high but common for the emerging markets. For liquidity measure, our sample firms have an average and median of liquidity of 1.134 and 0.861, respectively. Next, the tangible asset has its mean (median) at 0.209 (0.15), with a standard deviation of 0.185. The median and mean of market-to-book are 0.858 and 1.187, respectively. Finally, an average firm has the annual growth of total assets of 13.295.

Pearson's contemporaneous correlations are illustrated in [Table 3](#). [Table 3](#) shows that both the book leverage and the market leverage are negatively correlated with both cash ratios. Generally, these results support the argument that the cash holdings are inversely driven by the financial leverage. In other words, these results provide an initial picture of the financial leverage–cash holdings relationship. Furthermore, all correlation coefficients among independent variables in [Table 3](#) are less than 0.8. Following Klein's rule of thumb,<sup>2</sup> it can be concluded that independent variables in the equation are not seriously multi-collinear.

#### 4.2. Baseline regression results

[Table 4](#) represents the baseline regression results of the non-linear relationship between corporate leverage and cash holdings using the two-step SGMM technique for Equation (1). The results for the different cash holdings and firm leverage measures are differentiated by the column headings. We report the regression results for CASH1 and CASH2 as the dependent variables in Models (1)–(2) and Models (3)–(4), respectively. Additionally, Models (1), (2) and Models (3), (4) report the regression results for the book leverage and the market leverage as the measures of financial leverage, respectively.

In order to ensure the validity of our SGMM estimator, we report the test for the absence of second-order serial correlation and the Hansen test of overidentifying restrictions, which tests for the absence of correlation between the instruments and the error term. We find that the *p*-value of the Hansen test is insignificant, which reveals no evidence of overidentifying restrictions. Further, we also find that the *p*-value of AR (2) is insignificant, which indicates that a second-order autocorrelation does not exist in our SGMM model.

**Table 3. Pairwise correlations**

	CASH1	CASH2	BLEV	MLEV	SIZE	ROE	LIQ	TANG	MB	SG
CASH1	1									
CASH2	0.98***	1								
BLEV	-0.29***	-0.28***	1							
MLEV	-0.35***	-0.32***	0.85***	1						
SIZE	-0.13***	-0.13***	0.34***	0.35***	1					
ROE	0.25***	0.22***	-0.09***	-0.14***	0.04**	1				
LIQ	0.29***	0.30***	-0.60***	-0.32***	-0.21***	0.03*	1			
TANG	-0.15***	-0.15***	-0.02	0.22***	0.07***	0.01	-0.11***	1		
MB	0.17***	0.14***	-0.10***	-0.08***	0.07***	0.44***	0.07***	0.016	1	
SG	0.04**	0.03*	0.08***	0.08***	0.11***	0.22***	0.01	-0.10***	0.19***	1

Notes: CASH1 and CASH2 are the cash holdings; BLEV (MLEV) is the book (market) leverage; SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. The variable definitions are in Table 1.

**Table 4. The non-linear relationship between financial leverage and cash holdings—baseline results**

Variables	Model			
	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>
	(1)	(2)	(3)	(4)
CASH1 <sub>t-1</sub>	0.780*** (0.100)		0.794*** (0.097)	
CASH2 <sub>t-1</sub>		0.821*** (0.092)		0.830*** (0.091)
BLEV <sub>t-1</sub>	-0.125*** (0.031)	-0.238*** (0.052)		
BLEVS <sub>t-1</sub>	0.085*** (0.029)	0.171*** (0.046)		
MLEV <sub>t-1</sub>			-0.117*** (0.025)	-0.210*** (0.046)
MLEVS <sub>t-1</sub>			0.078*** (0.021)	0.144*** (0.037)
SIZE <sub>t-1</sub>	-0.002** (0.001)	-0.003** (0.001)	-0.002*** (0.001)	-0.003*** (0.001)
ROE <sub>t-1</sub>	0.006 (0.017)	-0.001 (0.027)	0.000 (0.016)	-0.010 (0.026)
LIQ <sub>t-1</sub>	-0.006*** (0.002)	-0.012*** (0.003)	-0.006*** (0.002)	-0.011*** (0.003)
TANG <sub>t-1</sub>	0.003 (0.010)	0.010 (0.015)	0.004 (0.010)	0.012 (0.015)
MB <sub>t-1</sub>	0.002 (0.002)	0.003 (0.003)	-0.003* (0.002)	-0.005* (0.003)
SG <sub>t-1</sub>	-0.019*** (0.004)	-0.029*** (0.007)	-0.019*** (0.004)	-0.029*** (0.007)
Constant	0.075*** (0.018)	0.111*** (0.027)	0.081*** (0.019)	0.119*** (0.029)
Fixed effects	FY	FY	FY	FY
Observations	4,775	4,775	4,775	4,775
AR(2)	0.458	0.902	0.454	0.907
Hansen (p-value)	0.313	0.514	0.312	0.514

Notes: CASH1 and CASH2 are the cash holdings; BLEV (MLEV) is the book (market) leverage; BLEVS (MLEVS) is the squared book (market) leverage; SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. Firm and year fixed effects (FY) are included in all Models. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parenthesis. The variable definitions are in [Table 1](#).

Our analysis is to provide empirical evidence on the non-linear relationship between corporate leverage and cash holdings. Therefore, our independent variables of interest are the squared book leverage (BLEVS) and the squared market leverage (MLEVS). However, to arrive at a more complete picture of the non-linear relationship between corporate leverage and cash holdings, we first report the regression results of the financial leverage–cash holdings relationship.

We find that the coefficients on the book leverage (BLEV) and the market leverage (MLEV) are negative and statistically significant at 1% across all models, suggesting the negative impact of

financial leverage on cash holdings.<sup>3</sup> Furthermore, we also find that the coefficients on the squared book leverage (BLEVS) and the squared market leverage (MLEVS) are positive and statistically significant at the 1% level, indicating that the corporate leverage-cash holdings relationship is non-monotonic with a U-shaped curve. Accordingly, financial leverage exerts a negative impact on cash holdings at low levels, but the relationship becomes positive at high levels of leverage. All in all, when we use both the book and market leverage as the measures of financial leverage as well as CASH1 and CASH2 as the measures of cash holdings, our analysis indicates that the corporate leverage is negatively associated with the cash holdings. Additionally, we also find that the non-linear relationship between financial leverage and cash holdings is a U-shaped curve that firms hold more cash when financial leverage is either very low or very high

We also estimated the maximum points the sign of the relationship between cash holdings and leverage changes from negative to positive. Accordingly, the maximum points of the hump-shaped relationship between financial leverage and cash holdings are in the range of 73.59% to 75% and 69.59% to 72.91% for CASH1 and CASH2 as the dependent variables, respectively.

Regarding the control variables, we find that most of the results are in line with prior literature (e.g., Drobetz & Grüniger, 2007; García-Teruel & Martínez-Solano, 2008; Guney et al., 2007; Hall et al., 2014; Opler et al., 1999). Specifically, the coefficients on SIZE are negative and significant in all models, suggesting that larger firms tend to hold larger amounts of cash. The negative and significant coefficients on LIQ appear in all models, indicating that firms with higher liquidity hoard more cash. The coefficients on SG are also negative and significant in all models, suggesting that firms with growth opportunities have high cash reserves. The coefficients on ROE and TANG are insignificant in all models, implying that profitability and tangible assets are not associated with cash holdings.

#### 4.3. Robustness tests

We perform four robustness checks in this section. Specifically, we test for the robustness of the non-monotonic relationship between financial leverage and cash holdings to (i) alternative measures of financial leverage, (ii) alternative measures of cash holdings, (iii) an alternative econometric method. Finally, we also examine whether the non-linear relationship between financial leverage and cash holdings is dominated by the global financial crisis.

##### 4.3.1. Alternative measures of financial leverage

Since the definition of financial leverage in existing studies is rich and noisy (Moradi & Paulet, 2019), the non-linear relationship between financial leverage and cash holdings is more likely to change to different definitions of financial leverage. Thus, we investigate whether our results are robust to different definitions of financial leverage. We delineate debt-to-equity ratio and net market leverage as two alternative measures of financial leverage commonly used in the literature and re-estimate Equation (1). The alternative measures of financial leverage are defined as follows: (i) debt-to-equity ratio (DEBT) is measured as the book value of total debt divided by the book value of equity (García-Teruel & Martínez-Solano, 2008; Moradi & Paulet, 2019); (ii) net market leverage (NML) is calculated as the book debt net of cash holdings divided by the sum of book debt net of cash and market equity (Danis et al., 2014).

Table 5 provides the regression results of the non-linear relationship between financial leverage and cash holdings with alternative measures of financial leverage. The results, reported in Models (1)–(4), are qualitatively similar to the baseline findings. The coefficients on the square of the alternative measures of financial leverage are positive and statistically significant at the 1% level, suggesting that the nonlinear relationship between financial leverage and cash values is with a U-shaped curve. Generally, our results are robust to using alternative measures of financial leverage.

**Table 5. Alternative measures of financial leverage**

Variables	Model			
	CASH1 <sub>t</sub>	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>	CASH2 <sub>t</sub>
	(1)	(2)	(3)	(4)
CASH1 <sub>t-1</sub>	0.781*** (0.100)		0.794*** (0.097)	
CASH2 <sub>t-1</sub>		0.822*** (0.092)		0.830*** (0.091)
DEBT <sub>t-1</sub>	-0.124*** (0.030)	-0.236*** (0.052)		
DEBTS <sub>t-1</sub>	0.084*** (0.028)	0.169*** (0.046)		
NML <sub>t-1</sub>			-0.116*** (0.025)	-0.208*** (0.045)
NMLS <sub>t-1</sub>			0.077*** (0.021)	0.142*** (0.037)
SIZE <sub>t-1</sub>	-0.002** (0.001)	-0.003** (0.001)	-0.002*** (0.001)	-0.003*** (0.001)
ROE <sub>t-1</sub>	0.006 (0.017)	-0.001 (0.027)	0.000 (0.016)	-0.010 (0.026)
LIQ <sub>t-1</sub>	-0.006*** (0.002)	-0.012*** (0.003)	-0.006*** (0.002)	-0.011*** (0.003)
TANG <sub>t-1</sub>	0.003 (0.010)	0.010 (0.015)	0.004 (0.010)	0.012 (0.015)
MB <sub>t-1</sub>	0.002 (0.002)	0.002 (0.003)	-0.003* (0.002)	-0.005* (0.003)
SG <sub>t-1</sub>	-0.019*** (0.004)	-0.029*** (0.007)	-0.019*** (0.004)	-0.029*** (0.007)
<b>Fixed effects</b>	FY	FY	FY	FY
<b>Constant</b>	0.075*** (0.018)	0.111*** (0.028)	0.081*** (0.019)	0.119*** (0.029)
<b>Observations</b>	4,775	4,775	4,775	4,775
<b>AR(2)</b>	0.458	0.902	0.453	0.907
<b>Hansen (p-value)</b>	0.313	0.514	0.311	0.513

Notes: CASH1 and CASH2 are the cash holdings; DEBT and NML are alternative measures of financial leverage; DEBTS (NMLS) is the squared DEBT (NML); SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. Firm and year fixed effects (FY) are included in all Models. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parenthesis. The variable definitions are in Table 1.

#### 4.3.2. Alternative measures of cash holdings

Both CASH1 and CASH2 are employed as the measures of cash holdings in the baseline regression to indicate the non-linear relation between financial leverage and cash holdings with a U-shaped curve. In our analysis, we use the alternative measures of cash holdings to examine whether the non-linear relation between financial leverage and cash holdings with a U-shaped curve is robust to different definitions of cash holdings. We employ two alternative measures of cash holdings commonly used in the literature and re-estimate Equation (1). The alternative measures of cash holdings are defined as follows: (i) CASH3 is the ratio of total cash and cash equivalents to total

asset; (ii) CASH4 is the ratio of total cash and cash equivalents to total asset minus total cash and cash equivalents plus short-term investment.

Table 6 reports the regression results of the non-linear relationship between financial leverage and cash holdings with alternative measures of cash holdings. The results in Models (1)–(4) show that the coefficients on the squared financial leverage remain positive and statistically significant at the 1% level, indicating that the financial leverage–cash holdings correlation is non-linear with a U-shaped curve. Generally, our results are robust to using alternative measures of cash holdings.

Table 6 reports the regression results of the non-linear relationship between financial leverage and cash holdings with alternative measures of cash holdings. The results in Models (1)–(4) show that the coefficients on the squared financial leverage remain positive and statistically significant at the 1% level, indicating that the financial leverage–cash holdings correlation is non-linear with a U-shaped curve. Generally, our results are robust to using alternative measures of cash holdings.

#### 4.3.3. *Alternative econometric method*

The SGMM estimator is well documented to be appropriate and commonly used in dynamic models. However, this estimator does not account for the presence of the fractional dependent variable (Elsas & Florysiak, 2015). In our specification, cash holdings are fractional (i.e., bounded between 0% and 100%). In other words, using the SGMM estimator to estimate Equation (1) does not take into account the fact that cash holdings are fractional. A newly proposed method for dynamic panel data models with fractional dependent variables termed DPF (Elsas & Florysiak, 2015; Loudermilk, 2007) can outperform other alternative estimators. Thus, we use the DPF estimator to check whether our results are potentially robust to the econometric method.

Table 7 represents the regression results of the non-linear relationship between corporate leverage and cash holdings using the DPF technique for Equation (1). We find that the coefficients on the squared book leverage (BLEVS) and the squared market leverage (MLEVS) are positive and statistically significant at the 1% level, indicating that the non-monotonic relationship between corporate leverage and cash holdings still holds when using an alternative econometric method.

#### 4.3.4. *Controlling for the global financial crisis*

The earlier discussions on financial leverage, cash holdings and the global financial crisis (e.g., Bates et al., 2009; Demirgüç-Kunt et al., 2020; Lemmon & Lins, 2003; Lian et al., 2011; Liu et al., 2012) indicate that corporate leverage and cash holdings are separately determined by the global financial crisis. Therefore, it is more likely that the non-linear relationship between corporate leverage and cash holdings could be potentially driven by the global financial crisis. We inherit Samarakoon (2011) to define the global financial crisis in 2008 and 2009. Our results are from a set of secondary data between 2007 and 2019 in which the global financial crisis appears.

Therefore, we re-estimate Equation (1) with the subsample from 2010–2019 to check whether the non-linear relationship between corporate leverage and cash holdings remains robust if we remove observations in the period of time from 2008 to 2009.

Table 8 provides the regression results of the non-linear relationship between financial leverage and cash holdings with the subsample from 2010–2019. We find that the coefficients on the squared financial leverage in Models (1)–(4) are all positive and statistically significant at the 1% level. Therefore, we conclude that the non-linear relationship between financial leverage and cash holdings is not determined by the global financial crisis.<sup>4</sup> As a potential explanation, although the global financial crisis influences financial leverage and cash holdings, the effect is not strongly sufficient to dominate the non-monotonic relationship between financial leverage and cash holdings.

**Table 6. Alternative measures of cash holdings**

Variables	Model			
	CASH3 <sub>t</sub>	CASH4 <sub>t</sub>	CASH3 <sub>t</sub>	CASH4 <sub>t</sub>
	(1)	(2)	(3)	(4)
CASH3 <sub>t-1</sub>	0.827*** (0.041)		0.896*** (0.047)	
CASH4 <sub>t-1</sub>		0.877*** (0.050)		0.876*** (0.049)
BLEV <sub>t-1</sub>	-0.153*** (0.036)	-0.247*** (0.072)		
BLEVS <sub>t-1</sub>	0.120*** (0.033)	0.185*** (0.061)		
MLEV <sub>t-1</sub>			-0.083*** (0.027)	-0.194*** (0.060)
MLEVS <sub>t-1</sub>			0.062*** (0.022)	0.136*** (0.046)
SIZE <sub>t-1</sub>	-0.004*** (0.001)	-0.007*** (0.002)	-0.005*** (0.001)	-0.008*** (0.002)
ROE <sub>t-1</sub>	0.016 (0.014)	-0.003 (0.028)	0.007 (0.014)	-0.008 (0.028)
LIQ <sub>t-1</sub>	-0.009*** (0.002)	-0.017*** (0.004)	-0.007*** (0.002)	-0.015*** (0.004)
TANG <sub>t-1</sub>	0.020*** (0.008)	0.027* (0.014)	0.018** (0.008)	0.028** (0.014)
MB <sub>t-1</sub>	0.000 (0.002)	0.004 (0.003)	-0.001 (0.002)	-0.003 (0.004)
SG <sub>t-1</sub>	-0.024*** (0.006)	-0.031*** (0.011)	-0.020*** (0.005)	-0.031*** (0.011)
Constant	0.123*** (0.017)	0.193*** (0.033)	0.105*** (0.017)	0.193*** (0.036)
Fixed effects	FY	FY	FY	FY
Observations	4,894	4,889	4,894	4,889
AR(2)	0.319	0.741	0.276	0.731
Hansen (p-value)	0.814	0.626	0.210	0.613

Notes: CASH3 and CASH4 are alternative measures of cash holdings; BLEV (MLEV) is the book (market) leverage; BLEVS (MLEVS) is the squared book (market) leverage; SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. Firm and year fixed effects (FY) are included in all Models. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parenthesis. The variable definitions are in [Table 1](#).

#### 4.4. Impact of long-term versus short-term debt

In our analysis, we use the book leverage and the market leverage as the measures of financial leverage. However, both the book leverage and the market leverage are decomposed into the short-term debt and the long-term debt. In Vietnam, short-term debt accounts for most of the financial leverage, which frequently occurs in developing markets (Le & Phan, 2017). Therefore, it is motivated to test the roles of short-term debt and long-term debt are heterogeneous in the non-linear relationship between financial leverage and cash holdings.



**Table 7. Alternative econometric method**

Variables	Model			
	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>
	(1)	(2)	(3)	(4)
CASH1 <sub>t-1</sub>	0.515*** (0.019)		0.516*** (0.019)	
CASH2 <sub>t-1</sub>		0.513*** (0.019)		0.513*** (0.019)
BLEV <sub>t-1</sub>	-0.164*** (0.043)	-0.283*** (0.075)		
BLEVS <sub>t-1</sub>	0.144*** (0.041)	0.234*** (0.072)		
MLEV <sub>t-1</sub>			-0.140*** (0.032)	-0.257*** (0.056)
MLEVS <sub>t-1</sub>			0.111*** (0.028)	0.197*** (0.048)
SIZE <sub>t-1</sub>	-0.017*** (0.003)	-0.027*** (0.005)	-0.017*** (0.003)	-0.027*** (0.005)
ROE <sub>t-1</sub>	0.011 (0.012)	0.007 (0.021)	0.008 (0.012)	0.003 (0.021)
LIQ <sub>t-1</sub>	-0.007*** (0.001)	-0.011*** (0.002)	-0.006*** (0.001)	-0.011*** (0.002)
TANG <sub>t-1</sub>	0.011 (0.013)	0.014 (0.022)	0.011 (0.013)	0.013 (0.022)
MB <sub>t-1</sub>	-0.004** (0.002)	-0.006** (0.003)	-0.007*** (0.002)	-0.013*** (0.003)
AG <sub>t-1</sub>	-0.012*** (0.004)	-0.016** (0.007)	-0.011*** (0.004)	-0.016** (0.007)
Constant	0.046** (0.019)	0.066** (0.032)	0.059*** (0.019)	0.088*** (0.032)
Observations	4,374	4,374	4,374	4,374

Notes: CASH1 and CASH2 are the cash holdings; BLEV (MLEV) is the book (market) leverage; BLEVS (MLEVS) is the squared book (market) leverage; SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. Firm and year fixed effects (FY) are included in all Models. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parenthesis. The variable definitions are in Table 1.

We follow Le and Phan (2017) to define short-term debt ratio (STD) as the book value of short-term debt divided by the book value of the total assets and long-term debt ratio (LTD) as the book value of long-term debt divided by the book value of the total assets. Using two disaggregated measures of financial leverage allows us to distinguish the non-linear relationship between short-term debt and cash holdings, and the non-linear relationship between long-term debt and cash holdings.

To investigate the existences of the non-linear relationship between short-term debt and cash holdings and the non-linear relationship between long-term debt and cash holdings, we delineate both the short-term debt ratio and the long-term debt ratio as two alternative measures of financial leverage commonly used in the literature and re-estimate Equation (1).

**Table 8. Controlling for the global financial crisis**

Variables	Model			
	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>
	(1)	(2)	(3)	(4)
CASH1 <sub>t-1</sub>	0.922*** (0.083)		0.925*** (0.083)	
CASH2 <sub>t-1</sub>		0.911*** (0.080)		0.912*** (0.080)
BLEV <sub>t-1</sub>	-0.134*** (0.031)	-0.261*** (0.056)		
BLEVS <sub>t-1</sub>	0.107*** (0.028)	0.198*** (0.048)		
MLEV <sub>t-1</sub>			-0.115*** (0.027)	-0.225*** (0.052)
MLEVS <sub>t-1</sub>			0.087*** (0.022)	0.162*** (0.040)
SIZE <sub>t-1</sub>	-0.002*** (0.001)	-0.003*** (0.001)	-0.002*** (0.001)	-0.004*** (0.001)
ROE <sub>t-1</sub>	-0.017 (0.018)	-0.029 (0.030)	-0.020 (0.017)	-0.035 (0.029)
LIQ <sub>t-1</sub>	-0.008*** (0.002)	-0.015*** (0.003)	-0.008*** (0.002)	-0.014*** (0.003)
TANG <sub>t-1</sub>	0.015* (0.009)	0.023* (0.014)	0.016* (0.009)	0.023* (0.014)
MB <sub>t-1</sub>	0.000 (0.002)	0.001 (0.003)	-0.004** (0.002)	-0.008** (0.004)
SG <sub>t-1</sub>	-0.016*** (0.004)	-0.021*** (0.007)	-0.016*** (0.004)	-0.021*** (0.007)
Constant	0.079*** (0.017)	0.145*** (0.026)	0.082*** (0.018)	0.153*** (0.029)
Fixed effects	FY	FY	FY	FY
Observations	4,107	4,107	4,107	4,107
AR(2)	0.278	0.714	0.283	0.724
Hansen (p-value)	0.192	0.663	0.204	0.673

Notes: CASH1 and CASH2 are the cash holdings; BLEV (MLEV) is the book (market) leverage; BLEVS (MLEVS) is the squared book (market) leverage; SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. Firm and year fixed effects (FY) are included in all Models. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parenthesis. The variable definitions are in Table 1.

Table 9 provides the regression results of the non-linear relationship between both short-term debt and long-term debt and cash holdings. We find that the coefficients on the squared short-term debt are all positive and statistically significant at the 1% level in Models (1) and (2), suggesting the non-monotonic relationship between short-term debt and cash holdings with a U-shaped curve. Additionally, we also find that the coefficients on the squared long-term debt are all positive and statistically significant at the 1% level in Models (3) and (4), indicating that the non-monotonic relationship between long-term debt and cash holdings with a U-shaped curve.

**Table 9. The non-linear relationship between financial leverage and cash holdings—short-term debt vs. long-term debt**

Variables	Model			
	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>	CASH1 <sub>t</sub>	CASH2 <sub>t</sub>
	(1)	(2)	(3)	(4)
CASH1 <sub>t-1</sub>	0.666*** (0.083)		0.682*** (0.080)	
CASH2 <sub>t-1</sub>		0.705*** (0.078)		0.715*** (0.074)
STD <sub>t-1</sub>	-0.115*** (0.035)	-0.162*** (0.049)		
STDS <sub>t-1</sub>	0.160*** (0.057)	0.228*** (0.081)		
LTD <sub>t-1</sub>			-0.134*** (0.029)	-0.178*** (0.039)
LTDS <sub>t-1</sub>			0.194*** (0.050)	0.271*** (0.071)
SIZE <sub>t-1</sub>	-0.003*** (0.001)	-0.005*** (0.001)	-0.001 (0.001)	-0.003** (0.001)
ROE <sub>t-1</sub>	0.017 (0.014)	0.002 (0.021)	0.013 (0.014)	-0.000 (0.020)
LIQ <sub>t-1</sub>	-0.003*** (0.001)	-0.005*** (0.002)	-0.002 (0.001)	-0.004* (0.002)
TANG <sub>t-1</sub>	-0.000 (0.008)	0.009 (0.011)	0.019*** (0.007)	0.032*** (0.011)
MB <sub>t-1</sub>	0.002 (0.001)	0.002 (0.002)	0.002 (0.001)	0.002 (0.002)
SG <sub>t-1</sub>	-0.014*** (0.004)	-0.021*** (0.006)	-0.013*** (0.004)	-0.019*** (0.006)
Constant	0.090*** (0.016)	0.135*** (0.024)	0.061*** (0.015)	0.096*** (0.022)
Fixed effects	FY	FY	FY	FY
Observations	4,894	4,894	4,894	4,894
AR(2)	0.637	0.930	0.600	0.941
Hansen (p-value)	0.246	0.253	0.195	0.226

Notes: CASH1 and CASH2 are the cash holdings; STD (LTD) is the short-term (long-term) debt; STDS (LTDS) is the squared short-term (long-term) debt; SIZE is the firm size; ROE is the return on equity; LIQ is the liquidity ratio; TANG is the tangible asset ratio; MB is the market-to book ratio; SG is the sale growth. Firm and year fixed effects (FY) are included in all Models. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parenthesis. The variable definitions are in Table 1.

All in all, both short-term debt and long-term debt are non-linearly related to cash holdings with a U-shaped curve.

### 5. General discussion

The complete picture of the non-linear relationship financial leverage and cash holdings in the context of Vietnam indicates that the financial leverage–cash holdings relationship is described as the U-shaped pattern. This finding lends strong support to our hypothesis. Our empirical evidence is in line with empirical evidence from both developed and emerging markets such as Drobetz and

Grüninger (2007); Guney et al. (2007); Hall et al. (2014); Nenu and Vintila (2017) and Thanatawee () who reveal the non-linear relation between cash holdings and leverage with a U-shaped curve that financial leverage negatively related to cash holdings appears at high levels of financial leverage and financial leverage positively related to cash holdings exists at low levels of financial leverage. This indicates that in spite of the differences of legal, institutional and macroeconomic conditions, the non-linear relation between cash holdings and leverage with a U-shaped curve exists in the context of an emerging market like Vietnam.

Our results support the argument related to the free cash flow theory and the pecking order theory that it would be expected that firms with higher leverage hold less cash at high levels of financial leverage and the trade-off theory that it would be expected that firms with higher leverage hold more cash at low levels of financial leverage.

The Vietnamese financial system is characterized by a bank-based system (Nguyen & Ramachandran, 2006) and the Vietnamese stock market is characterized as thin and infrequent trading in an inefficient and weak form (Loc et al., 2010). Accordingly, Vietnamese listed firms tend to take advantage of an arm's length relationship with their lenders to use loans as the most important source of financing. As a consequence, Vietnamese-listed firms are generally highly levered (Le & Phan, 2017) in spite of being incurred high costs of external financing since the Vietnamese financial system is under-developed and the investor protection is poor. Therefore, the addition of debt to adapt investment and operation could maximize corporate value since the benefits of debt (e.g., tax savings, mitigated manager-shareholder agency costs) overwhelm the costs of debt (e.g., financial distress and bankruptcy costs, stockholder-bondholder agency conflicts). However, to the extent that financial leverage is high enough that firms are on edge of financial distress and go into bankruptcy, they tend to allocate higher cash ratios to mitigate the likelihood of financial distress and reserves borrowing capacity.

## 6. Conclusions

Our analysis examines the non-linear relationship financial leverage and cash holdings in the context of an emerging market. Our final sample includes 513 firms listed on the Vietnamese stock market during 2007–2019 with 4,801 firm-year observations. We use the two-step SGMM technique to indicate the non-linear relationship between financial leverage and cash holdings with a U-shaped curve. Additionally, our findings are robust to the alternative measures of cash holdings, financial leverage, the alternative econometric method and the global financial crisis. Furthermore, we also find that both short-term and long-term debt are non-linearly related to cash holdings.

The results support the argument related to the free cash flow theory and the pecking order theory that it would be expected that firms with higher leverage hold less cash at high levels of financial leverage and the trade-off theory that it would be expected that firms with higher leverage hold more cash at low levels of financial leverage.

Our research indicates some implications for managers with respect to cash holdings when firms operate at high and low levels of financial leverage. Specifically, when firms operate at low levels of financial leverage, managers should tend to hold less cash and issue debt since the addition of debt to adapt investment and operation could maximize corporate value. In contrast, when firms operate at high levels of financial leverage, managers hoard cash to mitigate the likelihood of financial distress and bankruptcy as well as reserve borrowing capacity since highly levered firms are more likely to experience financial distress and go into bankruptcy. Additionally, we also provide implications for policy makers. Using liquid reserves before issuing debt when their investments exceed internally generated funds and paying down debt with internal surplus are positive. However, this is a part of our story, appearing at the low levels of financial leverage. The main content of our story is that firms at the high levels of financial leverage hoard cash to mitigate the likelihood of financial distress and bankruptcy because such firms are more likely to experience

financial distress and go into bankruptcy. However, hoarding cash to mitigate the likelihood of financial distress and bankruptcy is negative. Therefore, to take advantage of an arm's length relationship with their lenders to use loans as the most important source of financing to increase profitability and firm value, managers have incentive to reduce financial distress and bankruptcy for the increase of the turning point. The potential solution is that policy makers make policies to reduce the likelihood of experiencing financial distress and bankruptcy such as the decrease of cost of debt financing and the increase of the likelihood of equity financing.

We conclude that the non-linear relation between cash holdings and leverage in the Vietnam context is with a U-shaped curve that financial leverage negatively related to cash holdings appears at high levels of financial leverage and financial leverage positively related to cash holdings exists at low levels of financial leverage. However, our limitation is that we do not provide mechanisms through which the non-linear relation between cash holdings and leverage is established.

#### Acknowledgements

The authors would like to thank all those colleagues for their comments and suggestions at different phases of the research project.

#### Author details

Hung Phan Tran Minh<sup>1</sup>

ORCID ID: <http://orcid.org/0000-0001-9910-8780>

Kim Nguyen Thi<sup>1</sup>

ORCID ID: <http://orcid.org/0000-0002-6394-1495>

Loan Pham Thi Be<sup>2</sup>

E-mail: [loanptb@due.edu.vn](mailto:loanptb@due.edu.vn)

ORCID ID: <http://orcid.org/0000-0003-3256-5455>

<sup>1</sup> Present Position: Lecturer, University/Institution: Hoa Sen University, 08 Nguyen Van Trang, Ben Thanh Ward, District 1, Ho Chi Minh City, Vietnam.

<sup>2</sup> Lecturer, University/Institution: University of Economics, the University of Danang, 71 Ngu Hanh Son, Bac My An Ward, Ngu Hanh Son District, Da Nang City, Vietnam.

#### Author contributions

The authors contributed equally to this work. All authors have read and agreed to the published version of the manuscript.

#### Our group's key research activities

Our research interests lie in the area of corporate finance, financial markets, behavioral finance, and finance for real estate. Our current paper focuses on the dynamic model in corporate finance; specifically, it examines the non-linear relationship between financial leverage and cash holdings in the emerging market context by using this model which plays an increasingly prominent role in corporate finance research. Thereby, we offer implications for managers to operate their firms at different levels of financial leverage and for policymakers to draw up policies to reduce the likelihood of experiencing financial distress and bankruptcy.

#### Disclosure statement

No potential conflict of interest was reported by the author(s).

#### Citation information

Cite this article as: The non-linear impact of financial leverage on cash holdings: Empirical evidence from Vietnam, Hung Phan Tran Minh, Kim Nguyen Thi & Loan Pham Thi Be, *Cogent Business & Management* (2022), 9: 2114304.

#### Notes

1. A service provider of firms' financial data and analysis in Vietnam (company specializes in collecting and analyzing data on firms in Vietnam)
2. As a rule of thumb, multicollinearity is not serious if correlation coefficients among independent variable pairs are lower than 0,8 (Gujarati, 2003).
3. The existing empirical evidence on the financial leverage-cash holdings relationship is mixed in the context of Vietnam. Tran (2019) finds the positive relationship between financial leverage and cash holdings. However, this inference could be related to the endogeneity issue since the potential presence of reverse causality from the impact of cash holdings on financial leverage and other explanatory variables is not eliminated. Moreover, using the model with the dependent variable of the cash holding growth and the fixed-effects and random-effects estimators could not be fully reflected, even inducing misleading inferences on the financial leverage-cash holdings relationship. Additionally, the presence of the square of financial leverage could also result in bias and inconsistencies in the coefficient of financial leverage. In the meantime, our results are in line with most empirical evidence on the corporate leverage-cash holdings relationship in Vietnam. For example, Thu and Khuong (2018) and Khuong et al. (2020) show the negative effect of financial leverage on corporate cash holdings of the energy enterprises listed on Vietnam's stock market. Moreover, Nguyen and Nguyen (2021) find that financial leverage is negatively associated to cash holdings for all non-financial listed firms in Vietnam.
4. The global financial crisis could have effects on the economy after 2009. Therefore, we also use the subsample from 2013-2019 to test the influence of the global financial crisis. Our results show that the non-linear relationship between financial leverage and cash holdings is not driven by the global financial crisis. However, to conserve space, the results are unreported.

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