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The U-Shaped Effects of Financial Leverage and Firm Size on Cash Holding in Indonesia

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ABSTRACT

This study examines the impact of financial leverage and firm size on cash holdings in Indonesia and explores how these effects differ before and during the COVID-19 crisis. The research utilizes unbalanced panel data, comprising 209 firm-year observations from 2018 to 2020. The findings reveal that financial leverage and firm size exhibit a U-shaped relationship with cash holdings. Specifically, in companies with low financial leverage and small firm size, both financial leverage and firm size negatively affect cash holdings. Conversely, in companies with high financial leverage and large firm size, these factors positively influence cash holdings. The study also finds that financial leverage, regardless of whether it is low or high, has a consistent effect on cash holdings across the pre- and during-COVID-19 periods. However, the impact of firm size on cash holdings differs between small and large companies when comparing the pre-COVID-19 and during-COVID-19 periods. This research contributes to the literature on cash holdings by analyzing the U-shaped effects of financial leverage and firm size in manufacturing companies in Indonesia, employing a static random effects model.

ABSTRAK

Penelitian ini mengkaji dampak leverage keuangan dan ukuran perusahaan terhadap kepemilikan kas di Indonesia serta mengeksplorasi bagaimana pengaruh tersebut berbeda antara periode sebelum dan selama krisis COVID-19. Penelitian ini menggunakan data panel tidak seimbang yang terdiri dari 209 observasi firm-year selama periode 2018 hingga 2020. Temuan penelitian menunjukkan bahwa leverage keuangan dan ukuran perusahaan memiliki hubungan berbentuk U dengan kepemilikan kas. Secara spesifik, pada perusahaan dengan leverage keuangan rendah dan ukuran perusahaan kecil, leverage keuangan dan ukuran perusahaan berpengaruh negatif terhadap kepemilikan kas. Sebaliknya, pada perusahaan dengan leverage keuangan tinggi dan ukuran perusahaan besar, kedua faktor tersebut berpengaruh positif terhadap kepemilikan kas. Penelitian ini juga menemukan bahwa leverage keuangan, baik pada tingkat rendah maupun tinggi, memiliki pengaruh yang konsisten terhadap kepemilikan kas pada periode sebelum dan selama krisis COVID-19. Namun, dampak ukuran perusahaan terhadap kepemilikan kas berbeda antara perusahaan kecil dan besar ketika membandingkan periode sebelum dan selama krisis COVID-19. Penelitian ini memberikan kontribusi pada literatur mengenai kepemilikan kas dengan menganalisis pengaruh berbentuk U dari leverage keuangan dan ukuran perusahaan pada perusahaan manufaktur di Indonesia, menggunakan model efek acak statis.

1. INTRODUCTION

This study investigates the effect of financial leverage and firm size on cash holdings in manufacturing companies in Indonesia during the 2018–2020 period. Additionally, it examines how the effects of financial leverage and firm size on cash holdings differ before and during the COVID-19 crisis. A company's decision regarding the amount of cash reserves to maintain is critical in financial management, as it directly impacts the carrying costs of cash holdings. Companies hold cash for various reasons, including day-to-day operations, funding growth, repaying debts, transaction motives, and precautionary purposes (Jebran et al., 2019). However, determining the appropriate level of cash reserves requires careful consideration. Excess

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cash can lead to opportunity and agency costs (Arora, 2019), while insufficient cash may cause companies to miss profitable investment opportunities.

Previous research on the relationship between cash holdings, financial leverage, and firm size has produced mixed results (Maheshwari & Rao, 2017; Nenu & Vintilă, 2017; Siddiqua et al., 2019; Tayem, 2016). Analyzing cash holdings influenced by financial leverage and firm size using a single theoretical framework is insufficient. Instead, it is necessary to integrate the pecking order theory, free cash flow theory, and trade-off theory to better understand cash holding decisions (Siddiqua et al., 2019). Financial leverage and firm size are hypothesized to have a U-shaped effect on cash holdings. Previous studies have demonstrated that financial leverage has a U-shaped influence on cash holdings (Nenu & Vintilă, 2017; Tayem, 2016; Tran Minh et al., 2022). Similarly, firm size is also suspected to exhibit a U-shaped relationship with cash holdings.

This study offers several unique contributions compared to prior research. First, to the best of the authors' knowledge, no empirical evidence exists in Indonesia that examines the U-shaped effect of financial leverage on cash holdings. Previous studies in Indonesia have only analyzed the linear relationship between financial leverage and cash holdings (Arfan et al., 2017; Cheryta et al., 2018; Wijaya, 2021). However, studies in other developing countries have provided evidence of a U-shaped effect, making it an intriguing topic to explore in the Indonesian context. Second, empirical evidence on the U-shaped effect of firm size on cash holdings remains limited. Smaller companies, which have more restricted access to information and capital markets compared to larger firms, tend to hold substantial cash reserves to minimize transaction costs associated with cash management. On the other hand, larger companies maintain significant cash reserves to support investments, capture market share, and pursue business diversification. Third, this study examines the sensitivity of cash holding decisions to the COVID-19 crisis. During periods of economic uncertainty, companies tend to hold more cash (Chen et al., 2016). Furthermore, Chang and Yang (2022) argue that high cash holdings enable managers to address underinvestment problems during crises.

This research provides empirical evidence on the U-shaped effects of financial leverage and firm size on cash holdings, as well as the differences in these effects before and during the COVID-19 crisis. A U-shaped effect implies that low financial leverage and small firm size negatively affect cash holdings, while high financial leverage and large firm size positively influence cash holdings. The structure of this article includes an introduction, a review of the literature, and a description of the research methodology. The final section presents the conclusions and implications for profitable investment opportunities.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Theories commonly applied in corporate cash holding decisions include the trade-off theory, the pecking order theory, and the free cash flow theory (Tran Minh et al., 2022).

2.1. Trade-Off Theory

The trade-off theory suggests that companies determine an optimal level of cash holdings to maximize firm value (Chireka & Bamidele Fakoya, 2017). According to this theory, companies substitute debt with equity as part of their financial strategy. Diaw (2021) argues that debt acts as a substitute for cash, meaning that when a company's debt levels are high, its cash holdings tend to be low. Companies will choose to hold more cash when the benefits of doing so outweigh the costs associated with holding cash. Managers aim to maximize firm value by maintaining an optimal level of cash holdings (Tran Minh et al., 2022).

2.2. Pecking Order Theory

The pecking order theory, also referred to as the financing hierarchy, explains how companies prioritize funding sources for their financial needs (Arora, 2019). According to this theory, companies first rely on internal funding, such as retained earnings, to meet investment needs. If additional financing is required, they turn to debt, and equity is used as a last resort (Siddiqua et al., 2019). When internal funding is insufficient, companies may resort to high-cost external financing (Diaw, 2021). To preserve cash for investments, companies may delay or adjust dividend payments. In this context, cash balances serve as a buffer between retained earnings and investment requirements (Arora, 2019). Additionally, firms with higher profits tend to rely more on internal funds, thereby reducing their dependence on debt (Adair & Adaskou, 2015).

2.3. Free Cash Flow Theory

Rashid and Ashfaq (2017) explain that the free cash flow theory suggests that excess cash holdings, beyond what is needed to fund investments, can lead to agency conflicts between shareholders and managers. According to this theory, excess free cash flow may encourage managers to invest in unproductive projects that do not align with the interests of shareholders (Siddiqua et al., 2019). Additionally, large cash reserves provide managers with opportunities to use company funds for personal benefit (Le et al., 2018).

2.4. Financial Leverage and Cash Holding

According to the trade-off theory, companies hold more cash when the benefits of doing so outweigh the costs associated with cash holdings (Martínez-Sola et al., 2018). Conversely, if the costs of holding cash exceed the benefits, companies will maintain lower cash reserves. The benefits of holding cash are primarily driven by transaction costs and precautionary motives (Tran Minh et al., 2022). Under the transaction cost motive, companies hold more cash when the opportunity costs and the costs of obtaining additional cash are relatively high. For the precautionary motive, companies retain higher cash reserves to address urgent cash needs (Arora, 2019) and to mitigate the effects of information asymmetry when seeking external funding (Siddiqua et al., 2019). Additionally, companies with high levels of debt tend to maintain larger cash balances to manage financial difficulties and reduce the risk of bankruptcy (Siddiqua et al., 2019).

The pecking order theory suggests that companies prioritize internal funding sources, such as retained earnings, to finance operations and investments (Bensaadi et al., 2023). Companies with high profits tend to maintain higher cash levels to fund new investments using internal resources (Nenu & Vintilă, 2017). As a result, financial leverage reduces cash holdings, as companies rely less on external financing (Maheshwari & Rao, 2017). Similarly, the free cash flow theory links financial leverage to lower cash holdings, as higher debt levels reduce the availability of free cash (Rashid & Ashfaq, 2017).

Empirical evidence indicates that financial leverage has a U-shaped effect on cash holdings (Nenu & Vintilă, 2017; Tayem, 2016; Tran Minh et al., 2022). At low levels of financial leverage, cash holdings are negatively affected because debt serves as a substitute for cash, consistent with the pecking order and free cash flow theories (Tran Minh et al., 2022). However, when debt exceeds a certain threshold, companies increase their cash reserves to address financial constraints (Nenu & Vintilă, 2017). At high levels of financial leverage, cash holdings are positively influenced, aligning with the trade-off theory (Tran Minh et al., 2022). Companies with high leverage hold significant cash reserves for several reasons: to avoid opportunity costs and ensure sufficient liquidity to seize investment opportunities, to meet long-term investment needs, and to mitigate refinancing risks (Siddiqua et al., 2019). Tran Minh et al. (2022) argue that high financial leverage positively impacts cash holdings because companies face greater risks of financial distress, bankruptcy, and the need to preserve loan capacity. In such cases, companies increase cash reserves to reduce net debt and create a buffer for meeting interest obligations (Martínez-Sola et al., 2018).

Based on these theoretical frameworks and prior research, financial leverage is expected to exhibit a U-shaped effect on cash holdings. Low financial leverage negatively impacts cash holdings, while high financial leverage positively influences them.

H1. Financial leverage has a U-shaped effect on cash holdings.

2.5. Firm Size and Cash Holding

According to the trade-off theory, small companies with high growth potential and future risks tend to hold large amounts of cash because obtaining external financing is costly for them (Le et al., 2018). In contrast, large companies benefit from easier access to external financing at lower costs due to economies of scale. Large firms are generally more stable, generate higher profits, and face a lower risk of bankruptcy, which allows them to hold less cash (Jebran et al., 2019). Additionally, large companies are less dependent on internal funding sources (Diaw, 2021). Previous research has shown that firm size negatively affects cash holdings (Magerakis et al., 2020).

In contrast, the pecking order theory suggests a positive relationship between firm size and cash holdings. Larger companies are often considered more successful and tend to maintain higher cash levels to fund future investments (Le et al., 2018). These firms hold more cash to support their growth and success (Arora, 2019). Similarly, Siddiqua et al. (2019) found that firm size positively correlates with cash holdings. According to the free cash flow theory, managers of firms with large cash reserves are less reliant on external funding markets and are not required to provide detailed information about their investment projects

to outside investors (Le et al., 2018). Empirical evidence also supports the positive relationship between firm size and cash holdings (Martínez-Sola et al., 2018; Siddiqua et al., 2019). Rashid and Ashfaq (2017) further demonstrated that firm size positively affects cash holdings in financially unconstrained companies.

Based on theoretical and empirical evidence, firm size can influence cash holdings differently depending on the context. Firm size is hypothesized to have a U-shaped effect on cash holdings. Small companies tend to hold large amounts of cash to avoid transaction costs associated with obtaining additional funds. However, when transaction costs are low, smaller companies may hold less cash, as they can easily access additional funds or liquidate assets when needed (Tran Minh et al., 2022). Small firms often hold cash for transaction and precautionary motives, particularly when transaction costs exceed opportunity costs. In this context, firm size negatively affects cash holdings, consistent with the trade-off theory (Magerakis et al., 2020).

On the other hand, larger companies hold more cash to meet investment needs. The pecking order theory and free cash flow theory suggest that firm size positively affects cash holdings, as larger companies aim to achieve greater success in the future (Le et al., 2018). Large firms, with their broad market share, tend to accumulate significant cash reserves (Siddiqua et al., 2019). They are also more likely to diversify their businesses and maintain relatively stable cash flows (Rashid & Ashfaq, 2017). As a result, firm size positively influences cash holdings in larger companies.

Based on these theoretical frameworks and prior research, it is proposed that firm size has a U-shaped effect on cash holdings. Small firms hold more cash to address transaction costs, while large firms hold more cash to support investments and diversification.

H2. Firm size has a U-shaped effect on cash holdings.

2.6. Differences in the Effect of Financial Leverage on Cash Holding Before and During the COVID Crisis

The COVID-19 crisis significantly influenced corporate cash holdings. Previous research indicates that firms with lower financial constraints utilized more cash during the crisis due to their greater flexibility in liquidity management (Tran, 2020). Companies with low financial leverage tend to face fewer financial challenges, enabling them to use more cash while holding less in reserve. Consequently, during the COVID-19 crisis, firms with low financial leverage maintained lower cash reserves. In contrast, companies with higher financial leverage retained more cash during the crisis. This behavior is driven by transaction cost and precautionary motives, which encourage firms to increase cash holdings during periods of heightened uncertainty (Arora, 2019).

Transaction costs associated with cash management tend to rise during crises. Firms with high financial leverage are more susceptible to financial constraints and bankruptcy risks during such periods, prompting them to hold larger cash reserves. For these firms, cash becomes more valuable during crises compared to non-crisis periods (Chang & Yang, 2022). Research also shows that companies experiencing financial difficulties during a crisis tend to hold more cash than they did before the crisis (Ranajee & Pathak, 2019). This behavior aligns with the precautionary motive, which suggests that firms increase cash holdings in response to heightened risk to ensure sufficient liquidity (Tran Minh et al., 2022). Thus, during the COVID-19 crisis, firms with low financial leverage faced fewer financial constraints, while those with high financial leverage encountered greater financial risks. As a result, the U-shaped relationship between financial leverage and cash holdings differed between the COVID-19 crisis period and the pre-crisis period.

H3. The U-shaped relationship between financial leverage and cash holdings differs between the COVID-19 crisis and prior periods.

2.7. Differences in the Effect of Firm Size on Cash Holding Before and During the COVID Crisis

Firm size influences cash holdings differently during crisis periods compared to non-crisis periods. For small firms, holding higher levels of cash results in relatively large opportunity costs. Companies tend to hold less cash when the opportunity cost of maintaining cash reserves exceeds the transaction costs associated with liquidating non-cash current assets (Tran Minh et al., 2022). As a result, small firms adjust their cash reserves during crises, holding different amounts compared to pre-crisis periods.

In contrast, large firms typically perform better and have access to more resources than smaller firms, enabling them to maintain higher cash reserves during crises (Jebran et al., 2019). During periods of economic uncertainty, firms often increase their cash holdings to finance future investments (Horioka &

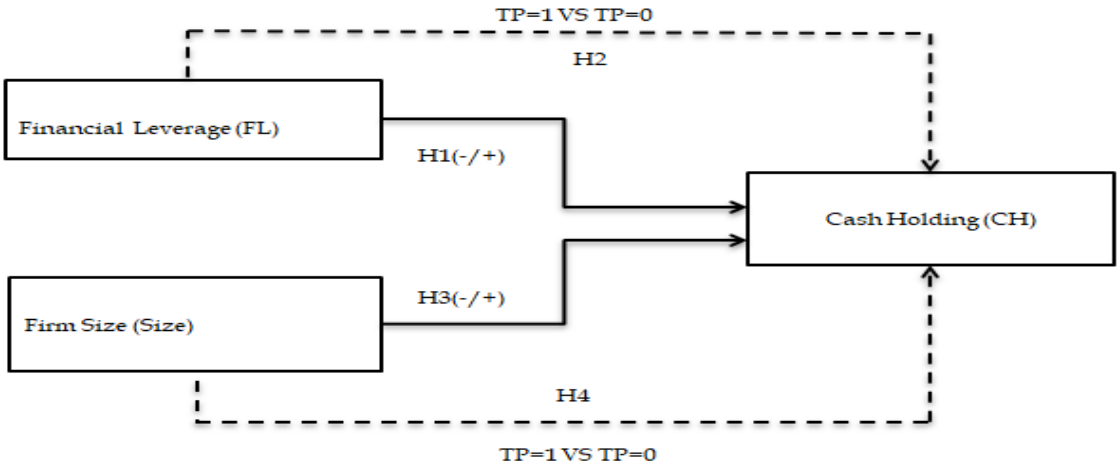

Figure 1. Research framework

Terada-Hagiwara, 2014). Larger firms, in particular, are more likely to generate higher profits and maintain substantial cash reserves, which allow them to secure a greater market share (Siddiqua et al., 2018). Firms with adequate cash balances are better equipped to address liquidity challenges, capitalize on productive investment opportunities, and sustain future growth (Chang & Yang, 2022). Therefore, firm size is expected to exhibit a different U-shaped effect on cash holdings during the COVID-19 crisis compared to the pre-crisis period.

H4. The U-shaped effect of firm size on cash holdings differs between the COVID-19 crisis and the pre-crisis period. The conceptual framework of this study is illustrated in Figure 1.

3. RESEARCH METHOD

3.1. Data Sources

This study focuses on manufacturing companies listed on the Indonesia Stock Exchange (IDX) during the 2018–2020 period. The data were obtained from the official IDX website (www.idx.go.id) and include information on total debt, total assets, and cash and cash equivalents. Due to data unavailability for some companies, the final sample consists of 74 companies with complete data for analysis. The study employs unbalanced panel data, comprising 209 firm-year observations.

3.2. Measurement of Variables

The dependent variable in this study is cash holding, which refers to the assets a company holds in readily available cash form. Cash holding is measured as the ratio of cash and cash equivalents to the company's total assets (Jebran et al., 2019; Siddiqua et al., 2019). The independent variables in this study are financial leverage and firm size. Financial leverage represents the amount of debt a company uses to finance its investments and business operations. It is a critical factor influencing cash holdings and is calculated as the ratio of the total book value of debt to the total book value of the company's assets (Arora, 2019; Tayem, 2016; Tran Minh et al., 2022). Firm size, another key variable affecting cash holdings, is measured using the natural logarithm of total assets (Jebran et al., 2019; Majid, 2021; Tran Minh et al., 2022). The inclusion of financial leverage and firm size as independent variables is based on prior research, which highlights the U-shaped relationship between financial leverage and cash holdings, as well as evidence suggesting a potential U-shaped effect of firm size on cash holdings (Tran Minh et al., 2022). Additionally, this study incorporates a dummy variable for the time period (TP) to examine the impact of the COVID-19 crisis.

3.3. Regression Model

This study employs a quadratic regression model to examine the effect of financial leverage and firm size on cash holdings. The quadratic regression approach is used to capture the nonlinear relationship between these variables and cash holdings. By using this method, the turning point at which the regression coefficient changes from negative to positive can be empirically identified within the research model. The model equation is presented as follows:

$$CH_{it} = \beta_{10} + \beta_{11}FL_{it} + \beta_{12}FL_{it}\text{^}2 + \beta_{13}Size_{it} + \beta_{14}Size_{it}\text{^}2 + \varepsilon_{it} \quad (1)$$

CH_{it} is the cash and cash equivalents of a company i at time t. ß$_{10}$ is an intercept. ß$_{11}$ – ß$_{14}$ are parameters that will be estimated from each independent variable. FLit is the financial leverage of company i at time t. FLit^2 is the squared financial leverage of company i at time t. Sizeit is the size of the company i at time t. Sizeit^2 is the squared size of the company i at time t. Ɛit is a random term error. The interaction coefficients for financial leverage, square of financial leverage, firm size, and square of firm size with TP (FL_{it}*(TP), FL_{it}^2*(TP), $Size_{it}$*(TP), and $Size_{it}$^2*(TP)) show the differences in the effects of financial leverage, square of financial leverage, firm size, and square of firm size on cash holdings between the pre-crisis period (TP=0) and the post-COVID crisis period (TP=1). The coefficients for FL_{it}, FL_{it}^2, Sizeit, and $Size_{it}$^2 reflect the impact of financial leverage, square of financial leverage, firm size, and square firm size on cash holdings during the pre-COVID crisis period (TP=0). The coefficients for FL_{it}+ FL_{it}*(TP), FL_{it}^2 + FL_{it}^2*(TP), $Size_{it}$ + $Size_{it}$*(TP), and $Size_{it}$^2 + $Size_{it}$^2*(TP) show the effects of financial leverage, square of financial leverage, firm size, and square of firm size on cash holdings during the COVID crisis period (TP=1).

This study investigates the impact of the COVID-19 crisis on the relationship between financial leverage, firm size, and cash holdings. It explores how financial leverage and firm size influence cash holdings differently before and during the COVID-19 crisis. The model equation is presented as follows:

$$\begin{aligned} CH_{it} = {} & \beta_{10} + \beta_{11}TP + \beta_{12}FL_{it} + \beta_{13}FL_{it}\text{^}2 + \beta_{14}Size_{it} + \beta_{15}Size\text{^}2_{it} + \beta_{16}FL_{it} * (TP) \\ & + \beta_{17}FL_{it}\text{^}2 * (TP) + \beta_{18}Size_{it} * (TP) + \beta_{19}Size_{it}\text{^}2 * (TP) + \varepsilon_{it} \end{aligned} \quad (2)$$

Model equation for the period before the COVID crisis (TP=0) is as follows:

$$CH_{it} = \beta_{10} + \beta_{12}FL_{it} + \beta_{13}FL_{it}\text{^}2 + \beta_{14}Size_{it} + \beta_{15}Size\text{^}2_{it} + \varepsilon_{it} \quad (2.1)$$

Model equation for the period during the COVID crisis (TP=1) is as follows:

$$\begin{aligned} CH_{it} = {} & \beta_{10} + \beta_{11} + \beta_{12}FL_{it} + \beta_{13}FL_{it}\text{^}2 + \beta_{14}Size_{it} + \beta_{15}Size\text{^}2_{it} + \beta_{16}FL_{it} \\ & + \beta_{17}FL_{it}\text{^}2 + \beta_{18}Size_{it} + \beta_{19}Size_{it}\text{^}2 + \varepsilon_{it} \end{aligned} \quad (2.2)$$

The time period (TP) is represented as a dummy variable in this study. It is assigned a value of 1 for the COVID-19 crisis period (2020) and 0 for the pre-crisis period (2018–2019). TP is introduced as a new variable in the research model equation. The interaction between the TP variable and the independent variables highlights how the effects of the independent variables on the dependent variable differ between the two time periods.

Panel data regression is used in this study, requiring the selection of an appropriate model from among the common effect model, fixed effect model, and random effect model (Gujarati & Porter, 2009). The suitability of these models is determined through statistical tests: the Chow test is used to distinguish between the common effect model and the fixed effect model, while the Hausman test is applied to differentiate between the fixed effect model and the random effect model.

4. DATA ANALYSIS AND DISCUSSION

4.1. Descriptive Statistics and Correlation Matrix

The descriptive statistics in Table 1 provide the mean, median, maximum, minimum, and standard deviation for the variables used in this study. The average cash holding (CH), measured as the ratio of cash and cash equivalents to total assets, is 0.09731, with a median value of 0.06934. This indicates that, on average, companies hold relatively low levels of cash. The average cash holding of Indonesian companies is comparable to that of Vietnamese companies (Tran Minh et al., 2022). For financial leverage (FL), the mean and median values are 0.38198 and 0.41132, respectively, suggesting that most company assets are financed through equity rather than debt. The standard deviation of financial leverage is 0.20573, indicating moderate variability among the sample companies. The average natural logarithm of total assets, used as a proxy

Table 1. Descriptive statistics of all variables

Variables	Mean	Median	Maximum	Minimum	Std.Dev
CH	0.09731	0.06934	0.45416	0.00196	0.08840
FL	0.38198	0.41132	0.78358	0.00078	0.20573
Size	27.47367	27.63529	29.96684	23.60088	1.38811

Note: CH is cash holding, FL is financial leverage, and Size is company size

Table 2. Correlation matrix

Correlation (t-statistics)	CH	FL	Size
CH	1		
FL	-0.210796 (-3.102534)***	1	
Size	-0.125342 (-1.817689)*	0.094315 (1.363031)	1

Note: ***p<0.01, *p<0.1

Table 3. Chow Test

Effects Test	Statistic	d.f	Prob.
Cross-section F	9.071539	(73,131)	0.0000
Cross-section Chi-square	376.389411	73	0.0000

Table 4. Hausman test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	4.070894	4	0.3965

for firm size, is 27.47367, which is very close to the median value of 27.63529. The standard deviation for firm size is 1.38811, reflecting relatively low variability in company size across the sample.

The correlation matrix in Table 2 reveals that financial leverage has a statistically significant negative correlation with cash holdings at the 1% significance level. Firm size also shows a negative correlation with cash holdings, significant at the 10% level. Lastly, firm size has a positive but statistically insignificant correlation with financial leverage.

4.2. Selection of an Appropriate Model

The selection between the common effect model and the fixed effect model is determined using the Chow test. As shown in Table 3, the Cross-Section F-Chow probability value is 0.0000 (< 0.05), indicating that the fixed effect model is more appropriate for the data. To choose between the fixed effect model and the random effect model, the Hausman test is applied. The results of the Hausman test are presented in Table 4. The Cross-Section Random Hausman Test probability value is 0.3965 (> 0.05), suggesting that the random effect model is the more suitable choice. Based on these results, this study employs the random effect model for hypothesis testing.

4.3. Regression Results and Discussion

4.3.1. Financial Leverage and Cash Holding

Table 5 presents the results of the random effect regression model, which examines the impact of financial leverage and firm size on cash holdings. The coefficient for financial leverage (FL) is negative and statistically significant at the 1% level, indicating that companies with lower debt levels tend to hold more cash. In contrast, the coefficient for quadratic financial leverage (FL^2) is positive and significant at the 5% level, suggesting that companies with higher debt levels maintain larger cash reserves. These findings confirm that financial leverage has a U-shaped effect on cash holdings, supporting **H1**. The turning point, where the effect of financial leverage on cash holdings shifts from negative to positive, is calculated to be 0.54 (0.33968 / (2 × 0.30888)). For companies with low financial leverage, the findings align with the pecking order theory and free cash flow theory (Tran Minh et al., 2022). These theories suggest that companies prefer internal funding sources, such as retained earnings, to finance investments and operations. As a result, firms with lower debt levels accumulate more cash to fund their investment projects and operations.

On the other hand, for companies with high financial leverage, financial leverage positively influences cash holdings. Firms with high debt levels require substantial cash reserves to address potential financial difficulties and mitigate bankruptcy risks (Nenu & Vintilă, 2017; Tran Minh et al., 2022). Addition-

Table 5. Regression results

Variables	Coefficient	t-Statistics
C	9.35270	3.92216***
FL	-0.33968	-2.96299***
FL^2	0.30888	2.24249**
Size	-0.67169	-3.82087***
Size^2	0.01225	3.78137***
R^2		0.11020
Adj. R^2		0.09275
F-Stat		6.31632***

Note: ***Significant level at 1%; **Significance level at 5%

ally, these companies maintain large cash reserves to capitalize on optimal investment opportunities, finance long-term projects at lower costs, and avoid the risks associated with refinancing (Siddiqua et al., 2019). The precautionary motive and the need to minimize transaction costs further encourage high-leverage firms to hold more cash.

This finding is consistent with the trade-off theory (Tran Minh et al., 2022), which suggests that the benefits of holding large cash reserves at high levels of financial leverage outweigh the associated costs. A shortage of cash can create unexpected challenges for companies, particularly when they face financial difficulties or bankruptcy risks due to high debt levels.

4.3.2. Firm Size and Cash Holding

The coefficient for firm size (size) is negative and statistically significant at the 1% level, while the coefficient for squared firm size ($size^2$) is positive and also significant at the 1% level (Table 5). These results indicate that firm size has a U-shaped effect on cash holdings. Specifically, the turning point at which the effect of the natural logarithm of total firm assets on cash holdings shifts from negative to positive is 27.42. Thus, the findings provide strong support for the H2 hypothesis.

Firm size negatively affects cash holdings in smaller firms, which aligns with the trade-off theory. For smaller firms, the primary consideration for holding cash is the cost of cash holdings. These firms tend to hold larger amounts of cash to maximize the benefits derived from cash-holding costs, which include opportunity costs and transaction costs. Additionally, the relatively low transaction costs associated with accessing cash reserves further incentivize smaller firms to maintain higher cash balances (Tran Minh et al., 2022). In contrast, larger firms are more likely to hold substantial amounts of cash. This behavior is driven by their investment needs, market share advantages (Siddiqua et al., 2019), and business diversification strategies (Rashid & Ashfaq, 2017). The positive relationship between firm size and cash holdings in larger firms is consistent with the pecking order theory and the free cash flow theory.

4.3.3. Differences in the Effect of Financial Leverage on Cash Holding Before and During the COVID Crisis

Table 6 presents the interaction effects of financial leverage (FL) and squared financial leverage (FL^2) with the COVID crisis period (TP) to analyze its impact. The negative coefficient for FL*(TP) and the positive coefficient for FL^2*(TP), both with a probability value greater than 0.1, indicate that financial leverage and squared financial leverage had a consistent effect on cash holdings during the COVID crisis period (2020) and the pre-crisis period (2018–2019). These results suggest that the COVID crisis did not significantly influence the relationship between financial leverage (or squared financial leverage) and cash holdings, thereby rejecting the H3 hypothesis. The findings further indicate that the COVID crisis was not a significant factor in explaining the effect of financial leverage on cash holdings.

Additionally, the negative coefficient for FL (-0.31914) and the positive coefficient for FL^2 (0.30179), as shown in Table 6, confirm that financial leverage had a U-shaped effect on cash holdings before the COVID crisis. During the COVID crisis, the coefficient for FL became more negative (-0.43958), calculated as -0.31914 + (-0.12044) (the sum of the coefficients for FL and FL*(TP)). Similarly, the coefficient for FL^2 increased to 0.4402, calculated as 0.30179 + 0.13841 (the sum of the coefficients for FL^2 and FL^2*(TP)). These results demonstrate that financial leverage maintained a U-shaped effect on cash holdings during the COVID crisis.

Table 6. Regression results of crisis sensitivity analysis

Variables	Coefficient	t-Statistic
C	8.89589	3.75457***
FL	-0.31914	-2.71670***
FL^2	0.30179	2.17277**
Size	-0.63848	-3.65014***
Size^2	0.01163	3.60254***
TP	4.59707	2.57953**
FL*(TP)	-0.12044	-1.11178
FL^2*(TP)	0.13841	0.93547
Size*(TP)	-0.32716	-2.49437**
Size^2*(TP)	0.00586	2.42859**
R^2		0.20845
Adj. R^2		0.17265
F-Stat		5.82300***

Note: ***Significant level at 1%; **Significance level at 5%

The findings suggest that companies with high financial leverage faced similar financial challenges both before and during the COVID crisis. Consequently, these companies did not increase their cash holdings during the crisis period. This result contrasts with previous studies, which have documented that cash holdings are more valuable for companies experiencing financial constraints during crises compared to non-crisis periods (Chang & Yang, 2022). Companies typically choose to hold more cash when the risk of insufficient liquidity rises.

Furthermore, the U-shaped effect of financial leverage on cash holdings, observed both before and during the COVID crisis, implies that companies experienced similar economic pressures in both periods. Companies with low financial leverage held substantial cash reserves in both periods, primarily for investment purposes. This highlights the consistent importance of internal funds for company development, regardless of the crisis period.

4.3.4. Differences in the Effect of Firm Size on Cash Holding Before and During the COVID Crisis

Table 6 presents the interaction effects of firm size (Size) and squared firm size (Size^2) with the COVID crisis period (TP). The negative coefficient for Size*(TP), with a probability value less than 0.05, indicates that the COVID crisis influenced the relationship between firm size and cash holdings. Similarly, the positive coefficient for Size^2*(TP), also with a probability value less than 0.05, suggests that larger firms held higher cash reserves during the COVID crisis compared to the pre-crisis period. These findings support Hypothesis H4. Further analysis reveals that the negative coefficient for Size (-0.63848) and the positive coefficient for Size^2 (0.01163) confirm that firm size had a U-shaped effect on cash holdings before the COVID crisis (Table 6). During the COVID crisis, the coefficient for Size became more negative (-0.96564), calculated as -0.63848 + (-0.32716) (the sum of the coefficients for Size and Size*(TP)). Meanwhile, the coefficient for Size^2 increased to 0.01749, calculated as 0.01163 + 0.00586 (the sum of the coefficients for Size^2 and Size^2*(TP)). These results confirm that firm size maintained a U-shaped effect on cash holdings during the COVID crisis.

Smaller firms held fewer cash reserves during the COVID crisis compared to the pre-crisis period. This can be attributed to higher cash transaction costs faced by smaller firms during the crisis, which discouraged them from holding larger cash reserves. In contrast, larger firms held substantial cash reserves during the COVID crisis to finance investments and support business diversification. Larger firms generally exhibit stronger performance and possess greater resources, enabling them to maintain higher cash balances during periods of crisis (Jebran et al., 2019). Moreover, large firms held significant cash reserves to capitalize on their market share advantages (Siddiqua et al., 2019), address liquidity challenges, and seize investment opportunities for future growth (Chang & Yang, 2022). These factors highlight the strategic importance of cash holdings for larger firms during the COVID crisis.

5. CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

This study investigates the U-shaped effects of financial leverage and firm size on cash holdings, as well as the differences in these effects before and during the COVID crisis. The analysis is based on unbalanced panel data comprising 209 firm-year observations from 2018 to 2020. The findings reveal that financial leverage exhibits a U-shaped effect on cash holdings. Specifically, financial leverage negatively influences cash holdings in companies with low debt levels, while it positively influences cash holdings in companies with high debt levels. Similarly, firm size also demonstrates a U-shaped effect on cash holdings. Small companies tend to hold large amounts of cash to minimize trading costs, whereas large companies retain substantial cash reserves to meet investment needs, support diversification, and seize opportunities for future growth.

The study also finds that the U-shaped effect of financial leverage on cash holdings remains consistent before and during the COVID crisis. However, the U-shaped effect of firm size on cash holdings differs between the two periods. During the COVID crisis, small companies held less cash compared to the pre-crisis period, while large companies retained more cash than they did before the crisis. These results provide important theoretical implications regarding the U-shaped effects of financial leverage and firm size on cash holdings, as well as the differences in these effects between pre-crisis and crisis periods. The findings also offer practical insights for managers and debt holders. For companies with low debt levels, managers are encouraged to prioritize internal funding sources. Conversely, companies with high debt levels tend to retain larger cash reserves to mitigate the risks of financial distress and bankruptcy. Notably, the study suggests that companies do not adopt a conservative cash policy during crises, even when they have high debt levels. Instead, managers of large companies tend to implement policies that involve holding more cash during economic crises.

This study employs quadratic regression, which has limitations in accurately identifying the intersection points between low and high levels of financial leverage and between small and large firm sizes. To address this limitation, future research is recommended to use piecewise regression to analyze the U-shaped effects of financial leverage and firm size on cash holdings. Piecewise regression allows researchers to determine cutoff points between low and high financial leverage and between small and large firm sizes through a trial-and-error approach, enabling more precise identification of these points.

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