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Research Paper

Investigating the Asymmetric Models of Cash Holding Adjustment Speed: Dummy Variable, Quadratic and Threshold Regression Models

Milad Emamgholipour Archi[a], Seyed Ali Nabavi Chashmi[b,]*, Iman Dadashi[c], Maryam Shafiee Kakhki[d]

[a]*Department of Accounting, Babol Branch, Islamic Azad University, Babol, Iran.*
[b]*Department of Management, Babol Branch, Islamic Azad University, Babol, Iran.*
[c]*Department of Accounting, University of Qom, Qom, Iran*
[d]*Department of Economic, Babol Branch, Islamic Azad University, Babol, Iran.*

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ABSTRACT

This study examines the adjustment speed of cash holdings using asymmetric models to efficiently manage cash and elucidate relevant optimization policies. The sample consists of 117 firms listed on the Tehran Stock Exchange, covering the period from 2009 to 2018. After identifying the optimal level of cash holdings, various asymmetric models, including the dummy variable approach, quadratic model, and threshold regression model, are employed to assess the adjustment speed of cash holdings. The findings indicate that cash-rich firms exhibit a higher rate of convergence towards optimal cash compared to cash-poor firms. Moreover, the results from the quadratic model reveal a non-linear, skewing effect of cash holding adjustment speed across different levels of cash. Thus, there exists an optimal cash holding level that allows firms to deviate from the cash target. If firms fall outside the optimal cash range, cash adjustment occurs at a faster pace, exhibiting both partial and asymmetric behavior.

1 Introduction

Cash is universally recognized as a critical and indispensable resource for companies and organizations. Similar to how blood sustains human life, cash fuels the economic survival of companies. It permeates every aspect of economic entities, directly or indirectly impacting all their activities. Consequently, cash holdings assume a crucial role in determining corporate financing policies [3], constituting a significant proportion of corporate assets.

The literature on cash holdings reveals intriguing reactions to the amount of cash held. On one hand, Almida et al. [2] argue that financially constrained firms maintain higher cash reserves to ensure ongo-

* Corresponding author.
E-mail address: *anabavichashmi2003@gmail.com*

ing access to funds, circumventing inefficient capital markets and costly external financing while capitalizing on valuable investment opportunities. However, holding excess cash also entails costs [15]. On the other hand, managers may misuse surplus funds, engaging in frivolous investments that deplete the company's free cash flow (as posited by agency theory) [18]. Furthermore, insufficient cash reserves for financially constrained firms may lead to missed investment prospects. Striking a balance between existing cash and cash requirements becomes a vital factor for the economic well-being and continuity of business entities.

Opler et al. [24] and Bates et al. [6] contend that an optimal level of cash holdings exists, striking a balance between the benefits and costs associated with cash reserves. However, one question remains largely unanswered: How do companies respond to deviations from the optimal cash level? As all firms experience cash flow imbalances, tracking the magnitude of cash distortions and the speed at which the cash balance adjusts to the target level becomes a significant issue [7]. In this study, we examine the speed of cash adjustment, positing that different adjustment costs prompt companies to follow distinct paths to reach their target cash level. Additionally, we explore the rate of adjustment across different cash regimes and estimate a threshold effect on cash adjustment behavior. Previous studies in finance have addressed dynamic equilibrium theory and analyzed the speed of adjustment in financial leverage (e.g., Flannery and Rangan [13]; Fowlkander et al. [12]). Although diverse findings have emerged from their research, they concur that companies (1) maintain the debt-to-equity ratio at an optimal level and (2) adjust their leverage to an optimal level based on adjustment costs. However, research specifically examining the speed of cash holdings adjustment is lacking in financial literature, except for the work of Jiang and Li [19]. Previous studies have demonstrated that firms maintain an optimal cash level [6, 24]. The rate of transition from available cash to optimal cash is referred to as cash adjustment speed, characterized by gradual adjustment in dynamic equilibrium theory and instantaneous adjustment in static equilibrium theory.

Numerous studies assume that all firms converge at the same rate toward the target cash level. However, unlike these studies, our research explores a threshold effect on cash retention rates. This approach enables companies to move toward different optimal cash levels based on their adjustment costs or value functions. Recently, Jiang and Li [19] investigated the adjustment speed of cash holdings, asserting that firms exhibit varying adjustment rates contingent on their current cash position. They found that firms with higher cash flow adjust more quickly than others.

In light of the aforementioned, our study calculates the cash holdings adjustment speed using a two-stage standard partial adjustment model. Furthermore, after determining the optimal cash balance level, we test asymmetric cash flow adjustment models, including (1) the dummy variable (livestock) model, (2) the quadratic model, and (3) the threshold regression model. In the first model, dummy variables categorize firms into high and low cash regimes based on the deviation degree between actual cash holdings and the optimal cash level. The quadratic model expands upon the standard partial adjustment model by incorporating quadratic expressions of the deviation variable from the optimal cash level. If one or more thresholds

exist, we examine the primary variable of interest based on these thresholds and allow the break points to be determined endogenously in both the quadratic and threshold regression models. To the best of our knowledge, there has been no previous research conducted in our country investigating the asymmetric models of cash holding adjustment speed, specifically the dummy variable, quadratic, and threshold regression models. Therefore, this study is pioneering in this field and contributes to the existing literature. The findings of this research can be valuable to investors, stakeholders, and students in related fields, serving as a basis for further research. Consequently, this study is considered innovative and provides a comprehensive context for future investigations. In the following sections, we review the relevant literature and research background, present the research methodology, discuss the findings, and conclude with the implications and suggestions for future research.

2 Literature and Research Background

The cash holdings adjustment speed is the rate at which real cash reacts to optimal cash. Optimal cash in the above phrase means the amount of cash that balances the benefits and benefits of maintaining cash. The optimal amount of cash is determined by the balance between the low return on holding of cash assets and the benefit of minimizing the need for external financing. In order to justify the nature and behavior of the rate of adjustment of cash holdings, various theories have been proposed in the financial literature. The basis of these theories is the theory of balance. This theory means that there is an optimal level of cash that the company can move at a point or a limited range of this optimal level [26]. Static Equilibrium Model: This theory implies that companies, in order to maximize their value and according to the ultimate benefits and costs of holding cash, simultaneously adjust their cash balance to the optimal level of holding cash [1]. According to the static equilibrium model, companies determine the optimal level of cash for themselves according to the conditions and situations that they face during the period, and if it is not predicted due to an event or due to a shock. If there is a change in their characteristics, they change their optimal level [31].
Dynamic Balance Model: Dynamic Cash Balance Model Considering market inconsistencies and costs incurred for adjustment, unlike the static balance model, believes that the immediate and immediate adjustment of cash to its optimal level at all times, It is not cost-effective and the adjustment of cash to optimal cash is gradual and over time [1]. Venkiteshwaran [31] states that contrary to the static balance theory in the dynamic balance model, the optimal level is not an exact point, but there is a range of the optimal level of cash in companies. When companies' cash flow exceeds the minimum or maximum optimal point, companies will seek to return to the optimal level according to their specific strategies. As mentioned, the static equilibrium theory believes in the immediate adjustment of cash to the optimal cash, but due to inconsistencies and market inefficiencies, this is not possible and it is expected that this adjustment will be gradual and in accordance with the dynamic equilibrium theory. Will happen. In this case, the speed of cash adjustment will be between zero and one [21]. The financial literature shows that despite some research on cash holdings adjustment speed, few studies have examined asymmetric cash holdings adjustment models. However, there is no research in Iran that directly addresses this issue. Therefore, in the following, related foreign and domestic researches will be reviewed. In his research, Truong [30] tested the characteristics of the company and the speed with which it maintained its cash holdings. In this study, the financial information of 417 non-financial companies of Vintami during the period 2010 to 2019 has been used. The results showed that companies with financial deficits have higher adjustment speeds than companies with financial surpluses.
Siddiqua *et al* [29] examined the asymmetric objectives of cash maintenance and financial constraints in Pakistani companies. By examining the asymmetric adjustment of cash holdings in Pakistani companies for companies with high and low optimal cash using the Generalized Torque (GMM) method, they showed that companies with higher cash than optimal cash had a higher adjustment rate than to companies that hold less cash than optimal. Also, limited companies in terms of financing, adjust their cash holdings faster than companies without financial restrictions. Cho *et al* [11] in a study examined

the relationship between managerial ability and the speed of adjustment of cash holdings. Their research findings indicate that there is a negative and significant relationship between managerial ability and the speed of cash adjustment. The results also show that in companies that use higher internal financing, the relationship between managerial ability and the speed with which cash is retained is weakened. Also, companies with higher management ability and cash surplus make less inefficient investments, and managers with high ability tend to keep larger amounts of cash to invest in a timely manner. Orlova and Rao [25] in a study entitled "Cash Adjustment Speed Adjustment" with a statistical sample from 1986 to 2012, state that companies with a cash deficit compared to companies with a cash surplus Criticism is slower to adjust. Bates *et al* [5] examined the value of cash. In part of their research, they concluded that the value of cash in companies with cash holdings below the optimal level is higher than in companies with cash holdings above the optimal level. In addition, the results of their research showed that cash value in companies with less-than-optimal level of maintenance increases over time compared to companies with more than optimal level of maintenance over time.

Jiang, and Lie [19] examined the relationship between cash maintenance adjustments and managerial biases. They found that, on average, companies cover 31% of the gap between the ratio of real cash to target cash each year. The cash adjustment rate will generally be faster when the actual cash ratio is higher than the target cash ratio, and the reason for this is probably that a decrease in cash is cheaper than an increase. But as companies become more impenetrable to the threat of takeover, they significantly reduce their cash adjustments at high cash ratios.

Evidence shows that profit-seeking managers are reluctant to distribute surplus cash and tend to maintain high levels of cash, except when there is external pressure on the company. Venkiteshwaran [31] in a study examined a minor adjustment to the optimal level of cash holding. The results showed that the cash of small companies and companies with cash deficit is adjusted to the optimal level of cash faster than large companies and companies with excess cash. Saber Mahani *et al* [27] tested the effectiveness of customer focus on the speed of cash adjustment in companies listed on the Tehran Stock Exchange. They used 140 companies listed on the Tehran Stock Exchange during the period 2011 to 2017. In order to test the research hypotheses, multiple linear regression model was used using combined data (combined method). The results of this study indicate a positive and significant effect of customer focus on the level of cash holdings and the cash holdings adjustment speed. In other words, in companies with a major customer, the level of cash holdings and the cash holdings adjustment speed were higher. These results indicate the importance and effectiveness of the company's major customers in increasing the level of cash hold and the speed of adjusting cash hold.

Karami Taleghani and Watan Parast [20] in a study examined the effect of financial distress on the rate of adjustment of cash holding with emphasis on growth opportunities and financial constraints. For this purpose, the statistical sample of the study, including 118 companies in the period 2013 to 2019, was selected from the companies listed on the Tehran Stock Exchange and the hypotheses were tested using combined data and generalized torque method. Their results indicate that the cash adjustment rate is faster in financially helpless companies than in non-financially helpless companies. Also, the effect of financial distress on the rate of adjustment of cash holding in companies with high growth opportunities and companies with financial constraints is greater than other companies.

Shakeri and Jahanshad [28] to test the speed of adjustments towards the flow of optimal cash at different stages of the company's business cycle (maturity, growth and decline) and to investigate the effect of financing risk and profitability on this speed and deviation from the flow of optimal cash with Use of financial information 163 companies active and listed on the Tehran Stock Exchange paid during the

period 2010-2015. The results showed that the stages of growth and maturity and the decline of the speed of different adjustments to the optimal cash flow, the most adjustment belongs to the maturity period and the least, belongs to the decline period, the financing risk on the gap between Real and optimal cash flow is effective and in conditions of high financing risk, this gap is greater and in other words, there is less adjustment speed, and in companies with high profitability, the speed of adjustment towards optimal cash flow is higher than companies with profitability.
Khani and Yousefi [21] in a study entitled "Investigation of the rate of adjustment of cash holding towards its optimal holding level in companies listed on the Tehran Stock Exchange using the generalized torque method" to investigate the optimal level of cash holding Cash as well as calculating the average speed of current cash adjustment towards the target level for Iranian companies. The results of their research indicated the existence of an optimal level of cash holding in Iranian companies. Also, by calculating the cash adjustment speed for the sample companies, which was equal to 0.657, they found that the adjustment speed was high in Iranian companies. In fact, this rate means that, on average, these companies are able to adjust more than half of the current cash deviations from their optimal cash level over a period of time.

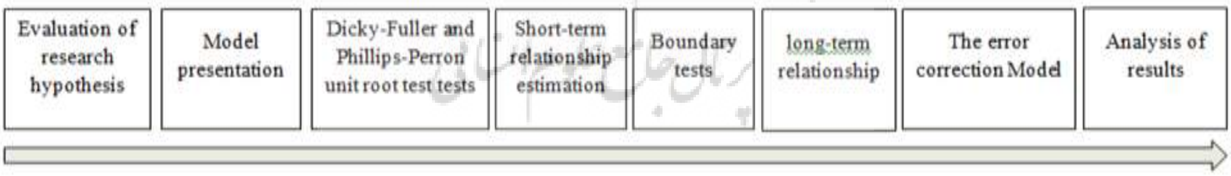
3 Research Process

3.1 Research Hypotheses

According to the theoretical foundations and research background, the following hypotheses are examined in this research:
Hypothesis 1: Companies with high cash regime have a faster adjustment rate than companies with low cash regime.
Hypothesis 2: The rate of adjustment of cash holding with respect to different levels of cash has a non-linear effect and nature.

3.2 Research Methodology

In this section, the research model and method are presented. The research steps are briefly presented in the form of a flowchart (1).



Flowchart 1: Research Steps

The present research is applied in terms of method and correlation and in terms of purpose and is considered as a descriptive accounting research. In addition, according to the historical information used to test its hypotheses, it is classified in a quasi-experimental research group. Also, in terms of epistemology, the present research is empirical, its reasoning system is inductive, and in terms of field-library study, it is post-event using historical information.

The statistical population of this research is the companies listed on the Tehran Stock Exchange in the period 2009 to 2018 that have the following conditions. Also, for some research variables, financial information is required from one year ago, and the required financial information was also collected in 2008.

1. In order for the information to be comparable, the financial year of the company should end at the end of March.
2. Except for banks, insurance and financial intermediaries.
3. All data required for the research are available for the surveyed companies.
4. During the research period, they have not stopped their activities and have not changed their financial period.

According to the above conditions and restrictions, a total of 117 companies were selected from the companies listed on the stock exchange.

3.3 Research Variables

As previously stated, the purpose of this study is to test asymmetric models for adjusting the cash holding speed of companies listed on the Tehran Stock Exchange. Therefore, to conduct this study and measure the speed of adjustment of cash holdings, the optimal level of cash holdings of companies must first be estimated.

3.3.1 Determining the Optimal Level of Cash Holdings (Target)

This study used the following equation for determining the target (optimal) cash holdings level:

$$Cash^{*}_{i.t} = \beta X_{i,t} \tag{1}$$

And in this model;

$Cash^{*}_{i.t}$: Optimal cash holdings of firm i in year t.

$X_{i,t}$: Characteristics vector of firm i in year t, including the set of factors that affect firm cash holdings.

β: Will be this vector's estimation coefficient which we seek to approximate.

According to the main theories of cash holdings (hierarchy theory, free cash flow theory, and the trade-off theory), the variables present in Opler *et al* [24], Bates *et al* [6], and Oler & Picconi [23] were used for determining cash holdings, and some variables were adjusted according to the current situation in Iran:

$$\begin{aligned}\mathrm{CashHoldings}_{i,t} = {} & \beta_0 + \beta_1 \mathrm{MB}_{i,t} + \beta_2 \mathrm{FirmSize}_{i,t} + \beta_3 \mathrm{CFO}_{i,t} + \beta_4 \mathrm{SalesGrowth}_{i,t} + \beta_5 \mathrm{NWC}_{i,t} + \\ & \beta_6 \mathrm{CAPX}_{i,t} + \beta_8 \mathrm{Leverage}_{i,t} + \beta_9 \mathrm{FirmAge}_{i,t} + \beta_{10} \mathrm{DividendDummy}_{i,t} + \beta_{11} \mathrm{Tax}_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{2}$$

Table 1 presents the calculations of variables in model (2):

Table 1: The Calculation of Variables in Model (2)

Variables	Calculation
Cash Holdings	Ratio of cash holdings to all assets. [10]
MB	Ratio of market value of dividends to book value of dividends. [10]
Firm Size	Natural logarithm of total assets. [10]
CFO	Operating cash flow divided by total assets.

Table 1: The Calculation of Variables in Model (2)

Variables	Calculation
Sales Growth	The difference between net sales of current and previous year divided by all assets.
NWC	Difference between net working capital and cash holdings divided by total assets.
CAPX	Change in net fixed assets divided by all assets.
Leverage	Ratio of all debts to all assets.
Firm Age	Natural logarithm of years since listed on the Stock Exchange.
Dividend Dummy	1 for paying dividends, otherwise 0.
Tax	Reported tax in cash flow statements divided by total assets.

Next, the theoretical background, the reasons for selecting the variables used for determining optimal cash holdings, and the relationship between variables and cash holdings are discussed. In model (2), market value variables are expected to have a positive correlation with book value (MB) and sales growth (SalesGrowth), which represent future growth opportunities with cash holdings. Firms with more future growth opportunities hold cash inside the company instead of outside financing to minimize the risk of losing investment opportunities (according to transaction and speculation motives). Meanwhile, companies that can convert their balance sheet to cash have lower cash holdings. The ability to convert assets to cash holdings is measured by net working capital (NWC); and firms with a high cash flow of operations (CFO) are expected to have Keynes' precautionary motive and be less inclined to have cash holdings as they prefer to use the cash they obtain in operations for their needs.

Regarding the divided variable (DividendDummy), firms that pay dividends are expected to have less cash holdings than other firms. One possible reason for this is that paying dividends creates legal obligations for firms, which can stabilize cash flows and reduce the level of cash holdings. Fast access to the capital market, measured using the firm size (FirmSize), firm age (FirmAge), and leverage (Leverage) variables, reduces the cost of external financing, and reduce firm cash holdings. The need for cash holdings for capital expenditures (CAPX) is also expected to increase cash holdings; and also, according to Keynes' transactions motive, firms that pay higher taxes are expected to have more cash holdings.

After fitness of model (2), similar to Chang *et al* [10], the model variables are used as the optimal level of cash holdings ($\beta_1, \dots, \beta_{13}$), and the optimal level of cash holding ($Cash_{i.t}^{*}$) was obtained by multiplying it in firm characteristics ($X_{i,t}$).

5.2 Measuring the cash holdings adjustment speed

In this study, to measure the rate of adjustment of cash holding, similar to the study of Chang *et al* [10], a two-stage standard partial adjustment model as described in Model (3) has been used, which is consistent with the studies of Byoun [8] and Faulkender *et al* [12].

$$\mathrm{Cash}_{i,t} - \mathrm{Cash}_{i,t-1} = \alpha + \lambda\left(\mathrm{Cash}_{i,t}^{*} - \mathrm{Cash}_{i,t-1}\right) + \varepsilon_{i,t} = \alpha + \lambda\left(\mathrm{CDE}_{i,t}\right) + \varepsilon_{i,t} \quad (3)$$

Where:

$\mathrm{Cash}_{i,t}$: The level of holding cash of company i in year t, which is measured by the ratio of cash to book value of assets of company i in year t.

$\mathrm{Cash}_{i.t}^{*}$: The optimal level of cash holding (target) of Company i in year t.

$\mathrm{CDE}_{i,t}$: The deviation between the optimal cash holding level (target) and the actual cash holding level of company i in year t.

λ: The rate of adjustment of the company's cash hold, which indicates the rate at which the company's cash hold level is moving towards the optimal level (target) at this rate. This coefficient is expected to be in the range of 0 and 1, and the higher the value, the faster the adjustment speed. It is also assumed that all companies adjust their cash holdings at the same speed λ. In a fully competitive market, the adjustment speed is one ($\lambda = 1$), in other words; If the optimal cash adjustment cost is zero, the actual cash holding level of a company ($\mathrm{Cash}_{i,t}$) should be equal to the target cash holding level; That is, $\mathrm{Cash}_{i,t} = \mathrm{Cash}^{*}_{i.t}$. However, if there are adjustment costs, the adjustments on the target cash from time t-1 to t will not be complete, i.e., the adjustment speed is less than one ($\lambda < 1$). In other words, when this number is one, it means that there are no adjustment costs or shocks and random events in the economy, and in fact in this case, the partial adjustment model is the same as the static equilibrium model. A zero rate also means that the current level of cash is unadjustable.
$\varepsilon_{i,t}$: is a component of model disruption.
In most foreign and domestic studies such as Jiang and Lie [19], Flannery and Rangan [13], Huang and Ritter [17], Khani and Yousefi [21], Shakeri and Jahanshad [28], Saber Mahani *et al* [27] and Karami Taleghani and Watan Parast [20] have used the one-stage partial adjustment model which is obtained by combining model (1) in model (3), which is in the form of model (4):

$$\mathrm{Cash}_{i,t} - \mathrm{Cash}_{i,t-1} = \alpha + \beta X_{i,t} + (1 - \lambda)\mathrm{Cash}_{i,t-1} + \varepsilon_{i,t} \tag{4}$$

Therefore, model estimation (4) faces two important problems. The first problem is the invisibility or immeasurability of the target cash holding level ($\mathrm{Cash}^{*}_{i,t}$) and the second problem is the presence of the variable cash level holding interval of the previous year ($\mathrm{Cash}_{i,t-1}$) Among the explanatory variables. Thus, due to the above problems in the one-stage model, the two-stage partial adjustment model, i.e., model (3) has been used in the development of asymmetric research models.

6 Research Models

In the present study, in accordance with the studies of Chang *et al* [10] to test the hypotheses of asymmetric models of cash holdings adjustment speed, including: Dummy, Quadratic (nonlinear) and Threshold regression models as described. The following are used:

6.1 The Dummy Variable Approach

The costs and benefits of cash holdings adjustment toward the target will differ depending on the situations of firms regarding optimal cash holdings (higher or lower cash holdings than the target). Model (5) is estimated for evaluating the difference in adjustment speeds of two groups of firms (high and low cash regime). The literature suggests that companies with more cash holdings than the target (high cash regime) will have slower cash holdings adjustment ($\lambda_H^{DV} > \lambda_L^{DV}$).

$$\begin{aligned}\mathrm{Cash}_{i,t} - \mathrm{Cash}_{i,t-1} \\ = \alpha + \lambda_H^{DV}\left(\mathrm{CDE}_{i,t} \times \mathrm{D}_{i,t}^{\mathrm{High}}\right) + \lambda_L^{DV}\left(\mathrm{CDE}_{i,t} \times \mathrm{D}_{i,t}^{\mathrm{Low}}\right) + \varepsilon_{i,t}\end{aligned} \tag{5}$$

Where:
$\mathrm{CDE}_{i,t}$: is the deviation from the optimal (target) cash holdings and actual cash holdings, which is used to divide firms into high and low cash regime.

$D_{i,t}^{High}$: is the dummy variable. If the firm's actual cash holdings is higher than optimal cash holdings, it is 1, and otherwise, it is 0 and considered high cash regime ($CDE_{i,t} < 0$ or $Cash_{i,t}^{*} < Cash_{i,t-1}$).
$D_{i,t}^{Low}$: is the dummy variable. If the firm's actual cash holdings is lower than the optimal level, it is 1, otherwise 0, indicating low cash regime ($CDE_{i,t} > 0$ or $Cash_{i,t}^{*} > Cash_{i,t-1}$).
λ_H^{DV} : Adjustment speed of firms with high cash regimes
λ_L^{DV}: Adjustment speed of companies with low cash regime

6.2 Quadratic or Nonlinear Model

In model (3), the linear effect of the speed of adjustment of cash holding of the company is tested. However, in this method, to investigate the nonlinear nature or curvature of the cash adjustment velocity, the quadratic model is used as described in Model (6):

$$Cash_{i,t} - Cash_{i,t-1} = \alpha + \lambda_1 CDE_{i,t} + \lambda_2 CDE_{i,t}^2 + \varepsilon_{i,t} \tag{6}$$

Where:
$CDE_{i,t}^2$: The square of the deviation between the optimal cash holding level (target) and the actual cash holding level of the company and the other variables are similar to model (3).
By examining this variable, two types of nonlinear U-shaped (∪) relationships and inverse U-shaped (∩) relationships can be expected. A U-shaped relationship occurs when, at the lower level of the independent variable, its negative effects on the dependent variable outweigh its positive effects; But after reaching a certain level, its positive effects begin to outweigh its negative effects. An inverse correlation also occurs when, at the lower level of the independent variable, its positive effects on the dependent variable are greater than its negative effects, and this relationship is reversed when the independent variable reaches a certain point [32].
According to the research literature, it is expected that the coefficient λ_2 is inverse (negative) and significant, which indicates the existence of nonlinear and asymmetric effects of cash deviations on cash adjustment. In other words, if this coefficient is significant in the research model, it can be concluded that the speed of cash adjustment is different for different amounts of cash in the company. If this coefficient is significant, the value of $\frac{-\lambda_1}{2\lambda_2}$ is known as the amount of cash deviations in the company that for larger or smaller amounts of cash held from this amount, the rate of adjustment of cash holding is different and Is asymmetric. Thus, companies that are in a high or low cash regime move to the optimal cash flow at a non-uniform rate, initially adjusting to a maximum point more rapidly and approaching the maximum point of the line slope. Less and less adjustment speed.

6.3 Threshold Regression Model

The threshold regression model based on Hansen's mixed data [16] is used to analyze the asymmetry of cash holdings adjustment speed in various holding levels. In the threshold panel approach, the likelihood ratio test is used to determine the threshold effect [16]. In this test, H_0 represents no threshold point, and the alternative hypothesis represents the threshold effect in the model. If H_0 is accepted, the model is linear, and if the threshold effect hypothesis is confirmed (turning point), the model will be nonlinear as follows:

High Cash regime: $\text{Cash}_{i,t} - \text{Cash}_{i,t-1} = \alpha + \lambda_H^{TR}\text{CDE}_{i,t} + \varepsilon_{i,t} \quad if\ CDE_{i,t} < \mu$

Low Cash regime: $\text{Cash}_{i,t} - \text{Cash}_{i,t-1} = \alpha + \lambda_L^{TR}\text{CDE}_{i,t} + \varepsilon_{i,t} \quad if\ CDE_{i,t} \geq \mu$

The threshold regression model allows: 1) To test whether there is such a threshold and where it occurs, and 2) measure the adjustment speed for each regime. Therefore, in case of one turning point, the afore-mentioned models will be written as model (7), and according to the research literature, firms with a high cash regime are expected to adjust cash holdings faster ($\lambda_H^{TR} > \lambda_L^{TR}$):

$$\text{Cash}_{i,t} - \text{Cash}_{i,t-1} = \alpha + \lambda_H^{TR}\text{CDE}_{i,t}(CDE_{i,t} < \mu) + \lambda_L^{TR}\text{CDE}_{i,t}(CDE_{i,t} \geq \mu) + \varepsilon_{i,t} \qquad (7)$$

Where:
μ: Indicating the hypothetical threshold value.
λ_H^{TR} : Adjustment speed of firms with high cash regime.
λ_L^{TR}: Adjustment speed of firms with low cash regime.
If two breakpoints are confirmed, Model (7) is classified into three regimes. Also, to test the first hypothesis of the research from the models of dummy variable approach and threshold regression, i.e., models (5) and (7); And to test the second hypothesis of the research, the second-degree model, i.e., model (6) is used.

7 Research Findings

7.1 Descriptive Statistics

The results of descriptive statistics of research variables are shown in Table 2. According to the table below, the average of variable cash is equal to 0.0411; therefore, it can be concluded that the surveyed companies hold an average of 4.11% of their assets in the form of cash and balances with banks. The average of net working capital variable is 0.1202 and the average sales growth rate is 0.1121, indicating that average sales have grown by 11.21% each year compared to the previous year. The average financial leverage is 0.6291 and indicates a high percentage of debt to equity of companies.
As can be seen in the table above, the average deviation from the optimal level of cash holding is negative (-0.0205), which in a way indicates that most companies hold more cash than needed and the optimal level of cash. Cash is a level less than the available cash. After determining the optimal level of cash holding, we test the research hypotheses.

7.2 Testing Research Hypotheses

7.2.1 Test results of the first hypothesis with a dummy variable approach

In the present study, before testing the regression models, the default regression tests are performed. One of the most important assumptions of any regression equation is the test of variance heteroscedasticity of error components, the first-order autocorrelation of perturbation sentences and the alignment of explanatory variables. If the number of sections (117 companies) is more than the time period (10 years 2009 to 2018), it can be expected that the components of the disorder have inequality of variance. The Breusch–Pagan test was used to test heteroscedasticity, and the first order autocorrelation of disturbance terms was tested using the Wald test. Table (3) presents the results of default tests and regression model estimation with a dummy variable approach. The coefficient of variance inflation (VIF) in the table below is less than 10, which indicates that there is no alignment between the explanatory variables of the research. The pagan test statistic was 104.85 and the significance level was 0.000, which indicates the problem of variance inequality. Also, the Weldrich test statistic was equal to 36.525 and the significance level was 0.000, which indicates the existence of first-order autocorrelation.

Table 2: Descriptive Statistics of Research Variables

Variables	Average	Maximum	Minimum	Standard Deviation
CashHoldings	0.0411	0.4702	0.0000	0.0479
MB	2.2524	16.6853	0.92808	2.1831
FirmSize	13.9231	19.2729	10.0312	1.4251
CFO	0.1083	0.6517	-0.3870	0.1270
SalesGrowth	0.1121	2.7806	-2.6953	0.2812
NWC	0.1202	0.6798	-2.2740	0.2820
CAPX	0.0261	0.8295	0.06078	0.1004
Leverage	0.6291	3.0604	0.0469	0.2983
FirmAge	2.7976	3.9318	1.6094	0.4466
DividendDummy	0.7376	1.0000	0.0000	0.4401
Tax	0.0158	0.1219	0.0000	0.0191
CDE	-0.0205	0.4518	-0.2174	0.0461

To address the heteroscedasticity and serial disturbance term autocorrelation problem for each company, after controlling for year and industry, the regression model fitness was conducted in STATA using the reinforced panel method with the VCE (Cluster Firms) command, and the following table shows the final output.

Table 3: The Test of Cash Holdings Adjustment Speed with Dummy Variable Approach

Variables	Coefficient (λ)	t Statistic	Sig	VIF
Constant	0.0010	0.28	0.777	--
$CDE*D^{High}$	0.6995	2.91	0.004	1.17
$CDE*D^{Low}$	0.6202	13.33	0.000	1.19
Year	Yes			
Ind	Yes			
R^2	0.2962			
Adjusted R^2	0.2770			
F-Statistic (Sig)	18.5034 (0.000)			
Breusch-Pagan Statistic (Sig)	104.85 (0.000)			
Wald Statistic (Sig)	36.525 (0.000)			

The results show that the coefficient λ_H^{DV} is equal to 0.6995 and the coefficient λ_L^{DV} is equal to 0.6202 and is significant at the error level of less than 5%. Thus, companies with high cash flow (companies that hold more cash last year than optimal cash or $\mathrm{CDE} \leq 0$) are faster than companies with low cash flow (companies which hold less cash last year than the optimal cash or $\mathrm{CDE} > 0$), move to the optimal cash. In other words, the cash adjustment rate is approximately 70% for companies with a high cash regime and 62% for companies with a low cash regime. Therefore, the speed of adjusting cash holding has an asymmetric behavior in relation to the liquidity levels of companies. As a result, the first hypothesis of the research is confirmed based on the dummy variable approach.

7.2.2 Test results of the first hypothesis based on the threshold regression model

In the first part of Table 4, the threshold test is presented. First, the test for the existence of a threshold (ie zero vs. one) is performed. The F-statistic and its significance level show that the null hypothesis, ie the absence of a threshold point, is rejected and the alternative hypothesis, ie the existence of a break-point or threshold at an error level of less than 5%, is confirmed with a value of -0.0542. According to the confirmation of the existence of a threshold, the test of the existence of two breakpoints in this research hypothesis (ie one against two) has been performed and the results have shown that there are no two threshold points. Therefore, the test of the research hypothesis is performed with a threshold and this threshold shows that when the amount of deviation from the level of optimal cash holding (CDE) reaches -0.0542, the rate of adjustment changes.

According to the second part of the table below, a threshold value of -0.0542 has been determined, which is the deviation from the level of optimal cash holding (CDE), ie ($Cash^{*}_{i,t} - \mathrm{Cash}_{\mathrm{i,t-1}}$) In the research regression model, based on observations, are classified into two cash regimes. The average deviation from the optimal cash holding level (CDE) is -0.0205 with a maximum of 0.4518 and a minimum of -0.2174 and the threshold point values are among the mentioned values. According to a study by Chang *et al* (2017), companies with deviations from the optimal cash holding level (CDE) less than -0.0542 as a high cash regime and companies with deviations from the optimal cash holding level (CDE) greater than 0.0542- are classified as low cash regime, the results of which are presented in the table below. The results showed that the cash holdings adjustment speed for companies with high cash regime (λ_H^{TR}) was 0.8779 and for companies with low cash regime (λ_L^{TR}) was 0.4559 with an error level of less than 5. The percentage is significant. Parent test statistics and its significance confirm the accuracy of the values of λ_H^{TR} and λ_L^{TR}. These findings suggest that firms adjust their cash faster when their actual cash holdings deviate a certain amount from the target or optimal amount. Therefore, the results indicate that companies with high cash regime move to the optimal cash flow faster than companies with low cash regime. In other words, the cash adjustment rate is approximately 87% for companies with a high cash regime and 45% for companies with a low cash regime. As a result, the first hypothesis of the research is confirmed based on the threshold regression model.

In addition, the results show that companies adjust their existing cash less quickly when their cash holding rate approaches the threshold value of -0.0542, and outside the target range, companies they will adjust their cash holdings much faster. As a result, the asymmetry of the cash adjustment velocity in the high and low cash regimes is confirmed.

Table 4: The Test of Cash Holdings Adjustment Speed with Threshold Regression Model

Part One: Threshold Test			
Number of Thresholds	**F-Statistic**		
0 to 1 (Threshold Level)	20.2078*		
1 to 2 (Threshold Level)	2.7964		
Part Two: The Threshold Regression Model Estimation Results			
Variables	**Coefficient (λ)**	**t Statistic**	**Sig**
High Cash regime:	**CDE < -0.0542**		
Constant	0.0509	8.71	0.000
CDE	0.8779	17.11	0.000
Low Cash regime:	**CDE ≥ -0.0542**		
Constant	0.0148	10.70	0.000
CDE	0.4559	7.91	0.000
R^2	0.3419		
Adjusted R^2	0.3402		

F-Statistic (Sig)	201.9983 (0.000)
Durbin-Watson	2.0802
Wald Statistic (Sig)	29.92535 (0.000)

* Significant at 5%

The Durbin-Watson statistic, which indicates no autocorrelation, is 2.0802. Durbin-Watson should be between 1.5 and 2.5.

7.2.3 Test results of the second hypothesis through quadratic or nonlinear model

Table 5 presents the results of the default tests and the estimation of the regression model based on the quadratic model. The coefficient of variance inflation (VIF) in the table below is less than 10, which indicates that there is no alignment between the explanatory variables of the research. The Breusch-Pagan test statistic was 93.89 and the significance level was 0.000, which indicates the problem of variance inequality. Also, the Wald Statistic was equal to 37.055 and the significance level was 0.000, which indicates the existence of serial autocorrelation between the error components of the model. To address the heteroscedasticity and serial disturbance term autocorrelation problem for each company, after controlling for year and industry, the regression model fitness was conducted in STATA using the reinforced panel method with the VCE (Cluster Firms) command, and the following table shows the final output.

Table 5: The Test of Cash Holdings Adjustment Speed with Quadratic Model

Variables	Coefficient (λ)	t Statistic	Sig	VIF
Constant	0.0018	0.68	0.496	--
CDE	0.5315	6.50	0.000	2.93
CDE^2	-0.8371	-1.67	0.099	2.74
Year	Yes			
Ind	Yes			
R^2	0.2998			
Adjusted R^2	0.2807			
F-Statistic (Sig)	18.8233 (0.000)			
Breusch-Pagan Statistic (Sig)	93.89 (0.000)			
Wald Statistic (Sig)	37.055 (0.000)			

The results of the test for the existence and nature of the nonlinear or curvature effect of the cash adjustment rate adjustment according to the different levels of cash are presented in the table above. It should be noted that according to Friedrich [14], when a variable is used with its square, the coefficient of the variable does not provide meaningful information and its square coefficient should be considered. Thus, considering that the coefficient of variation of the deviation from the optimal cash holding level (CDE) is equal to 0.5315 and is positive and also the square coefficient of deviation from the optimal cash holding level (CDE^2) is equal to -0.8371 and at the error level of 10% It is significant and negative, the relationship of the independent square variable with the dependent is U inverted or inverted (∩) (if the coefficient of the square variable is positive, the relationship is U) and the second hypothesis of the research is accepted.

Thus, the results show that companies that are in a high or low cash regime move to the optimal cash with a non-uniform speed, and initially the adjustment to the maximum point (0.3175) is faster and closer to Going to the maximum point, the line slope decreases and the adjustment speed decreases. As

a result, the second hypothesis of the research confirms that the rate of cash adjustment adjustment for companies with high and low cash regime is nonlinear and asymmetric in nature.
According to the modified method of [11], to calculate the maximum point of the research equation, we must derive from the CDE in the following equation:

$$\mathrm{Cash}_{\mathrm{i,t}} - \mathrm{Cash}_{\mathrm{i,t-1}} = 0.5315\,CDE - 0.8371\,\mathrm{CDE}^2$$

Finally, the equation is as follows:

$$0 = 0.5315 - 0.8371\,CDE \quad \rightarrow \quad CDE = 0.3175$$

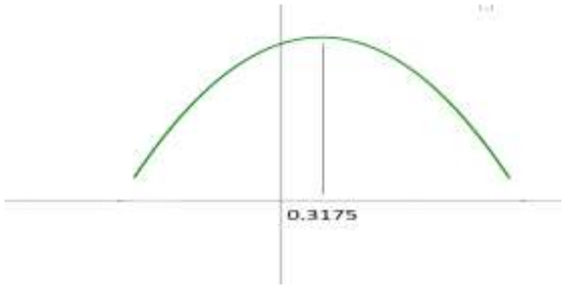


Fig. 1: Cash Holding Adjustment Speed based on Nonlinear Model

According to the significance level of F-test in determining the overall significance of the regression model presented in Table 5, which is less than the 0.05 error, it can be accepted that the overall significance of the model was confirmed. The adjusted coefficient of determination indicates that 28% of the dependent variable changes are explained by independent variables.

8 Conclusion and Discussion

Based on the literature and research hypotheses, cash adjustment is expected to be faster among companies in the high cash regime than in companies in the low cash regime. Because it is argued that companies are conservative and always keep enough cash in the company for emergencies. In this research, asymmetric models of cash holdings adjustment speed, which include: dummy variable approach, quadratic and threshold regression, are investigated through segmentation according to the results of relevant tests. Take. To test the research hypotheses, the financial information of 117 companies listed on the Tehran Stock Exchange has been used, which have been selected after applying the restrictions in this study. The results of the linear model test of the cash holdings adjustment rate indicated that companies were moving towards an optimal cash rate of approximately 65% on average. In other words, in one year they fill 65% of the gap between last year's real cash and the optimal cash. The results showed the confirmation of research hypotheses. Thus, the first hypothesis test, which was based on the models of dummy variable approach and threshold regression, the findings indicated that the rate of adjustment of cash holdings in companies with high cash regime compared to companies in the regime. Low cash is faster.
Also, the results of testing the second hypothesis have shown that companies that are in a high or low cash regime move to the optimal cash with a non-uniform speed, and initially the adjustment to the maximum point is faster. And as we approach the maximum point, the slope of the line decreases and the speed of adjustment decreases. These findings suggest that firms adjust their cash faster when their actual cash holdings deviate a certain amount from the target or optimal amount. Therefore, companies with high cash regime move to the optimal cash flow faster than companies with low cash regime. As

a result, the rate of adjustment of cash holdings is asymmetric in relation to corporate liquidity levels. The findings of this study are consistent with the results of studies by Chang *et al* [10], Siddiqua *et al* [29], Orlova and Rao [25], and Jiang and Lie [19]. However, according to the findings of the Venkiteshwaran [31] study, which showed that the cash flow of small companies and companies with cash deficit is faster than large companies and companies with excess cash to the surface. Optimal cash is adjusted, not aligned.

Since the speed with which cash is adjusted refers to how cash is retained relative to its optimal ratio, it is not unreasonable to expect that a firm's access to cash resources can influence these changes. Companies with high cash resources will be more able to adjust their cash holdings. Financing activities from domestic cash sources or increase the cash held from operating income in these companies are more easily done, while companies with less cash resources, more restrictions. Are incurred in adjusting the cash held. Therefore, as expected, the cash holdings adjustment speed in companies with high liquidity should be faster than companies with low liquidity, but on the other hand, it should be noted that the rate of deviation of retained cash from its optimal ratio in this relationship is effective. As long as the existing deviations from the optimal ratio of retained cash are not significant, no adjustment has been made in the cash holdings and therefore the speed of adjustment will be reduced. Therefore, it is suggested that the type of asymmetry in the rate of adjustment of cash holding should be considered according to the amount of deviation from the optimal ratio. It is also suggested that the cash held in the company be stored purposefully and with planning based on the allocation of resources to each of the financing, operational and investment activities. Clarifying the share of these activities in the cash held in the company can modify and correct management decisions regarding how to use these resources.

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