THE THRESHOLD EFFECT OF CAPITAL STRUCTURE ON FIRM VALUE: EVIDENCE FROM LISTED REAL ESTATE COMPANIES

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Abstract

This study examines the non-linear relationship between capital structure and firm value for listed real estate companies in Vietnam. Using a threshold regression model on a panel dataset of 60 companies from 2017 to 2024 (480 firm-year observations), and employing the debt-to-asset (DA) ratio as the threshold variable, the results reveal two significant thresholds in the impact of capital structure on firm value (measured by Tobin's Q). Specifically, when the DA ratio is below 45.14 percent, capital structure has a positive impact on firm value; when the DA ratio exceeds 45.14 percent but remains below 56.18 percent, the positive effect diminishes; and when debt usage surpasses 56.18 percent, capital structure exerts a distinct negative impact on firm value. These findings suggest an optimal debt threshold of 56.18 percent, implying that listed real estate firms should exercise caution when exceeding this level of leverage. The findings of this study are consonant with the trade-off theory. Overall, the results provide strong empirical evidence supporting a non-linear capital structure-firm value relationship in an emerging real estate market. The findings offer important managerial implications for corporate financial decision-making, particularly in identifying an optimal leverage range, and contribute to the existing literature by highlighting the relevance of threshold effects in capital structure analysis.

Keywords: Capital Structure, Threshold Model, Firm Value, Real Estate

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1. INTRODUCTION

The real estate sector plays a pivotal role in the Vietnamese economy, not only as a capital-intensive industry but also for its strong spillover effects on other sectors such as construction, banking and finance, material production, and support services. According to data from the Ministry of Planning and Investment for the 2020–2030 period, the real estate sector's contribution to gross domestic product (GDP) was approximately 7.7% in 2020 and is projected to reach 9.72% by 2025 and 13.6% by 2030 (Anh, 2021). Additionally, the total value of real estate assets was estimated to account for about 20.8% of the nation's total assets in 2020, with a forecast to increase to 22% by 2030 (Anh, 2021). These figures underscore the sector's significant influence on sustainable development and macroeconomic stability.

However, a defining characteristic of Vietnam's real estate sector is its high degree of financial leverage. Due to substantial capital requirements, real estate enterprises rely heavily on debt financing for their projects, leading to higher debt-to-asset (DA) ratios compared to other industries (Duc & Quang, 2022). Bank credit allocated to the real estate sector constitutes about 20–25% of the total outstanding loans in the financial system, elevating systemic risk in the event of market volatility (Ngo, 2023; Le, 2023). While debt usage can generate benefits from the tax shield and amplify profits (Modigliani & Miller, 1963), it also entails significant financial risks, particularly when leverage surpasses a safe threshold (Jensen & Meckling, 1976).

Capital structure—the mix of debt and equity a firm uses to finance its assets—directly affects its cost of capital, risk profile, and ultimately, its value (Almajali et al., 2012). Selecting an optimal capital structure is not merely a strategic financial decision but also reflects a firm's ability to balance the benefits and costs of debt (Laksana et al., 2024; Pahala et al., 2025; Syafik et al., 2025; Yeboah et al., 2024). In modern finance theory, the relationship between capital structure and firm value is not simply linear. Recent research suggests the existence of thresholds in capital structure, at which the impact of debt on firm value changes significantly (Lin & Chang, 2011). Specifically, when financial leverage exceeds a certain level, interest expenses and the risk of insolvency outweigh the financial benefits, thereby reducing firm value. Conversely, if a firm uses too little debt, it may forgo potential financial advantages (Sahoo & Yarso, 2024).

While several studies in Vietnam have investigated the impact of capital structure on firm value, most have adopted linear models, which fail to fully capture the non-linear nature of this relationship. This is particularly true for the real estate sector, where high cyclicality and significant financial risks create complex market behaviors (Tung et al., 2019). Furthermore, these capital structure thresholds have not been clearly identified for the Vietnamese context, and international studies are often based on different industries or countries with distinct developmental conditions.

Therefore, a study on the non-linear impact via a threshold model of capital structure on the value of listed real estate firms in Vietnam is both timely and necessary. This research not only contributes to refining capital structure theory in a new context but also offers profound practical implications for corporate managers, investors, and regulatory bodies in assessing risk, optimizing capital structure, and enhancing firm value sustainably.

The structure of this paper is as follows. Section 2 reviews the relevant literature. Section 3 analyses the methodology that has been used to conduct empirical research on the threshold effects of capital structure on firm value. Section 4 presents and discusses the empirical results. Finally, Section 5 concludes the paper by summarizing the main findings and outlining implications and directions for future research.

2. LITERATURE REVIEW

2.1. The theory of capital structure thresholds

In economics and finance, many relationships between variables do not follow a simple linear pattern but may change in magnitude or direction when certain conditions are met (Hansen, 1999). A common approach to modeling this non-linearity is the use of a threshold model, which allows the model's parameters to vary according to specific values of a threshold variable (Tong, 1990). The threshold model is particularly useful for analyzing relationships between financial variables with conditional properties, as it allows for the existence of different "regimes" within the dataset, reflecting changes in the nature of the causal relationship when one or more critical thresholds are crossed.

The concept of a threshold refers to specific value points at which the relationship between an independent and a dependent variable changes significantly, either in direction or magnitude. Identifying these thresholds allows for a deeper exploration of the dynamic and complex characteristics of firm or financial market behavior.

A capital structure threshold is the level of the debt-to-total capital ratio (or debt-to-equity ratio) at which the impact of debt on a specific economic or financial variable changes in direction or degree (Hansen, 1999; Seo & Shin, 2016).

2.2. Empirical studies on capital structure and firm value

Initial empirical studies on the impact of capital structure, particularly the debt ratio, on firm value often focused on a linear relationship, yielding mixed results.

Some studies found a negative relationship, arguing that higher debt leads to a decrease in firm value due to increased financial risk and potential bankruptcy costs. Research has shown an inverse relationship between capital structure and return on equity (ROE) and return on assets (ROA). Olajide et al. (2017) analyzed data from the Nigerian Stock Exchange (1996–2014), using ROA, ROE, earnings per share (EPS), and Tobin's Q as firm performance measures and the debt ratio as a proxy for capital structure. Their findings indicate a significant negative relationship between capital structure and firm performance in Nigeria, attributing this to relatively high agency costs. Across African countries, they also observed a mixed relationship between capital structure and firm performance. Other studies by Ahmed Sheikh and Wang (2013).

Conversely, some studies found the opposite, suggesting that debt usage can increase firm value through tax shield benefits and financing growth opportunities. Abor (2005) investigated the relationship between ROE and capital structure variables for 22 listed firms on the Ghana Stock Exchange from 1998–2002. The results showed that the short-term debt ratio and total debt ratio had a positive relationship with profitability (ROE). The study also indicated that the ROE of firms depended more on debt than on other financial variables. This finding is consistent with studies by Vijayakumaran (2017), Siddik et al. (2017), and Acaravcı (2015).

Some studies found no significant relationship between capital structure and firm value or financial performance, consistent with the original Modigliani-Miller irrelevance proposition (Vega Zavala & Santillán-Salgado, 2019; Al-Taani, 2013). The inconsistency in findings from linear models likely prompted the exploration of more complex, non-linear relationships, such as those involving quadratic, cubic, and threshold functions.

Several studies have concluded that the relationship between firm performance and capital structure is quadratic or cubic. Shen (2017) showed that firm performance is heavily influenced by capital structure. Performance was inversely related to capital structure when the debt ratio exceeded 37.6%, with the opposite effect observed below this threshold. Ghosh (2008), studying the impact of dividend policy, financial leverage, and profitability on firm value, found a quadratic relationship between future firm value and financial leverage.

A number of studies have specifically examined the existence of thresholds in the relationship between capital structure and firm value, using Hansen's (1999) panel threshold regression models to identify points where the impact of leverage on firm value changes significantly. Cheng et al. (2010) used threshold regression to analyze the threshold effect of the debt-to-total-assets ratio on the firm value of 650 listed companies from 2001–2006. The results indicated three different thresholds. When the debt ratio was below 53.97%, debt had a positive impact on firm value. The impact remained positive but weakened when the debt ratio was between 53.97% and 70.48%. When the debt ratio exceeded 70.48%, especially above 75.26%, the impact turned negative, significantly reducing firm value. Similarly, Nieh et al. (2008) found an optimal debt threshold for electric utility companies in Taiwan, suggesting that the debt ratio should be maintained between 12.37% and 28.70% to maximize firm value; ratios exceeding 51.57% or below 12.37% were not beneficial. Lin and Chang (2011), studying listed companies in Taiwan, identified two important leverage thresholds at 9.86% and 33.33% (debt-to-equity ratio). Below 9.86%, debt had a positive impact; between 9.86% and 33.33%, the impact weakened; and above 33.33%, no statistically significant relationship was found. In Vietnam, Duc and Luan (2014) studied the optimal debt limit for listed companies. Using a sample of 191 companies on the Ho Chi Minh and Hanoi stock exchanges from 2005–2012, they found a two-threshold effect of debt on profitability. Specifically: 1) when the debt ratio was below 56.67%, debt had a positive impact on profitability; 2) between 56.67% and 69.72%, the impact turned negative; 3) when the debt ratio exceeded 69.72%, the negative impact became stronger. While Duc and Luan (2014) provided early evidence of a nonlinear relationship between leverage and firm performance in Vietnam, their analysis focused on the profitability of a broad sample of listed firms and did not examine firm value or sector-specific dynamics. In contrast, the present study investigates threshold effects of capital structure specifically on firm value in the real estate sector, a highly leveraged and policy-sensitive industry where capital structure behaves differently from the market average. By employing a sector-focused sample and applying threshold regression to firm value rather than profitability, this study expands upon and differentiates itself from Duc and Luan (2014), thereby offering more targeted insights into leverage thresholds relevant to real estate firms in Vietnam.

3. RESEARCH METHODOLOGY

3.1. Research method

As outlined by Hansen (1999, 2000), the threshold regression framework is formulated using a balanced panel dataset (y_{it}, q_{it}, x_{it} $1 \le i \le n$, $1 \le t \le T$). The specification of a single-threshold model is given as:

$$y_{it} = \mu_i + \beta_1' x_{it} I(q_{it} \le \gamma) + \beta_2' x_{it} I(q_{it} > \gamma) + \varepsilon_{it} \quad (1)$$

where, i refers to the individual unit, and t denotes the time index. In this context, y_{it} stands for the response variable, q_{it} serves as the threshold indicator, and x_{it} represents a vector of explanatory variables.

Here, i denotes an indicator function that activates depending on the threshold condition. Equation (1) can alternatively be written in piecewise form as:

$$y_{it} = \begin{cases} \mu_i + \beta_1' x_{it} + \varepsilon_{it}, & if\ q_{it} \le \gamma \\ \mu_i + \beta_2' x_{it} + \varepsilon_{it}, & if\ q_{it} > \gamma \end{cases} \quad (2)$$

Threshold estimation (γ): Following Hansen (1999), the threshold parameter γ is estimated by minimizing the sum of squared residuals through a grid search procedure. The corresponding coefficients β are obtained using the ordinary least squares (OLS) method.

Model threshold test: After performing the bootstrap procedure on the sample data, the corresponding p-value is derived. According to Hansen (1996), this p-value is critical in determining whether to reject the null hypothesis (H_0). If the p-value is lower than the critical values, then H_0 is rejected, confirming the existence of a threshold effect in the model.

If there exist two threshold values, γ_1 and γ_2, with the assumption that $\gamma_1 < \gamma_2$, the model can be reformulated as follows:

$$y_{it} = \mu_i + \beta_1 x_{it} I(q_{it} \le \gamma_1) + \beta_2 x_{it} I(\gamma_1 < q_{it} \le \gamma_2) + \beta_3 x_{it} I(q_{it} > \gamma_2) + \varepsilon_{it} \quad (3)$$

This is equivalent to the piecewise specification:

$$y_{it} = \begin{cases} \mu_i + \beta_1 x_{it} + \varepsilon_{it}, & if\ q_{it} \le \gamma_1 \\ \mu_i + \beta_2 x_{it} + \varepsilon_{it}, & if\ \gamma_1 < q_{it} \le \gamma_2 \\ \mu_i + \beta_3 x_{it} + \varepsilon_{it}, & if\ q_{it} > \gamma_2 \end{cases} \quad (4)$$

Similarly, in models with more than two thresholds, the threshold values are ordered increasingly as $(\gamma_1, \ldots, \gamma_n)$, and the model is extended accordingly to allow for $n + 1$ distinct regimes.

While this study employs a panel threshold regression model following Hansen (1999) to capture potential non-linear effects of capital structure on firm value, alternative empirical approaches could also be considered. For instance, quadratic or cubic regression models may be used to test for non-linearity in a parametric framework. Panel smooth transition regression models represent another suitable alternative, allowing for smooth regime changes rather than discrete thresholds. Additionally, dynamic panel estimators such as the system generalized method of moments could be employed to address potential endogeneity concerns. However, the threshold regression approach is preferred in this study as it allows for the explicit identification of leverage breakpoints and provides a clear economic interpretation of different leverage regimes.

3.2. Research data

The study employs secondary data obtained from the audited consolidated financial statements of 60 listed real estate firms on the Ho Chi Minh Stock Exchange (HOSE) and Hanoi Stock Exchange (HNX) over the period 2017–2024, resulting in a panel dataset comprising 480 observations. The use of a balanced panel is particularly important in threshold regression analysis, as it ensures consistent estimation across regimes and avoids distortions arising from unequal time observations. A balanced structure also facilitates comparability across firms and improves the stability of the estimated threshold values. Nevertheless, the use of a balanced panel may introduce potential sample selection bias, as firms with missing observations are excluded. These excluded firms may differ systematically in terms of size, financial stability, or risk characteristics. Therefore, the findings should be interpreted with caution, and future studies may consider unbalanced panels to further validate the results.

Threshold regression, following the methodology proposed by Hansen (1999), is applied to examine the existence of thresholds and to estimate their values in the relationship between capital structure and firm value. The threshold variable is defined as the debt ratio, enabling the assessment of the nonlinear effects of financial leverage on firm value within Vietnam's listed real estate sector. To identify the optimal thresholds and their corresponding confidence intervals, the Bootstrap method is employed with a 95% confidence level.

Owing to the technical requirements of the threshold regression model for panel data, the sample is restricted to firms with complete and continuous data throughout 2017–2024. Specifically, for the *ROA* variable, to calculate the business risk (*RISK*) variable as the standard deviation of *ROA* using a rolling window of $k = 3$ years, the dataset is extended back to 2014.

3.3. Model specification

3.3.1. Dependent variable

The author uses Tobin's Q (*TobinsQ*) as a proxy for firm value because it represents the firm's asset value adjusted for market value. Among market-based value metrics, Tobin's Q is a robust tool for assessing firm value. This indicator has been used in several studies (Singh & Bansal, 2016; Aggarwal & Padhan, 2017; Vega Zavala & Santillán-Salgado, 2019; Nguyen, 2025). According to Tobin (1969), Tobin's Q is measured as:

$$Tobin's\ Q = \frac{Market\ value\ of\ assets}{Replacement\ cost\ of\ assets} \quad (5)$$

As determining the replacement cost of assets is practically difficult, empirical studies often use the approximation formula by Chung and Pruitt (1994):

$$Tobin's\ Q \approx \frac{Market\ capitalization + Market\ value\ of\ preferred\ stock\ (if\ any) + Book\ value\ of\ total\ debt}{Book\ value\ of\ total\ assets} \quad (6)$$

3.3.2. Explanatory and threshold variable: Capital structure

Capital structure (*DA*) is the main independent variable in this research model. In the threshold regression model, the capital structure variable will also serve as the threshold variable, defining the different "regimes" in which its impact on firm value changes in direction or magnitude.

In this study, capital structure is measured using the total debt-to-total assets ratio, which captures the firm's overall leverage, including both short-term and long-term debt. This measure is widely adopted in empirical research examining the effects of leverage on firm value and financial performance (Olajide et al., 2017; Acaravcı, 2015; Aggarwal & Padhan, 2017; Vijayakumaran, 2017; Chadha & Sharma, 2015; Ma, 2015). Previous studies have shown that total debt is a reliable indicator for analyzing nonlinear or threshold effects of leverage on firm outcomes in emerging markets (Shen, 2017; Cheng et al., 2010; Nieh et al., 2008). Measuring capital structure through total debt provides a comprehensive view of a firm's financial leverage, particularly in industries where the distinction between short-term and long-term debt is less pronounced.

In the real estate sector, firms typically employ both short-term and long-term debt, with long-term borrowing generally preferred for financing large development projects, while short-term debt is used to manage working capital needs. This approach ensures that the full impact of leverage on firm value and financial performance is adequately captured, especially in the context of real estate companies operating in emerging markets, where both types of debt significantly influence risk and returns. Therefore, the total debt-to-total assets ratio is an appropriate and consistent metric for examining the relationship between financial leverage and firm value among listed real estate companies in Vietnam.

3.3.3. Control variables

Return on assets

Fama and French (1995) show that profitability is a significant factor in explaining variations in stock returns (and thereby firm value). Many studies on capital structure and firm value, such as Lang and Stulz (1994), McConnell and Servaes (1995), and Demsetz and Villalonga (2001), all use *ROA* or *ROE* as a control variable and often find a positive impact on Tobin's Q.

Firm size

Firm size (*SIZE*) is often expected to have a positive impact on firm value. Larger companies have advantages in diversification, which helps reduce risk, easier access to capital markets at a lower cost due to greater transparency and better credit reputation, and can benefit from economies of scale as well as greater market power (Diamond, 1989; Titman & Wessels, 1988). Empirical studies by Abor (2005), Aggarwal and Padhan (2017), Zeitun and Tian (2007), and Nguyen (2025) show that firm size has a positive impact on firm value. However, a study by Sinebe (2024) found a negative and significant relationship between firm size and Tobin's Q, implying that larger companies may be undervalued due to management costs and internal risks that increase with size.

Growth rate of revenues

Abor (2005) argues that companies with high growth rates will have high profitability. Empirical research by Aggarwal and Padhan (2017), Lang and Stulz (1994), McConnell and Servaes (1995), and Nguyen (2025) reinforces this, showing that firms with more growth opportunities often have higher firm value. At the same time, these companies tend to use less debt to maintain financial flexibility and avoid the underinvestment problem, thereby preserving value from future growth opportunities. In this study, the authors use the growth rate of revenues (*GROW*) to determine the firm's growth rate.

Asset tangibility

Research by Alathamneh et al. (2025) indicates that tangible assets have a direct positive influence on the market value of a firm, as measured by Tobin's Q. Tangible assets not only support collateral capacity but also enhance firm value when managed effectively. The study by Berger and Ofek (1995) found a positive relationship between the ratio of tangible assets and firm value (measured by Tobin's Q), suggesting that physical tangible assets (*TANG*) can act as a factor that increases investor confidence and enhances market valuation.

Firm age

Diamond (1989) emphasizes that reputation, which can be accumulated through years of operation, is a decisive factor in accessing credit, helping firms obtain more favorable borrowing conditions. Similarly, Jovanovic (1982) argues that long-surviving firms are often more efficient, have more stable cash flows and financial reputation—thereby gaining easier access to capital and increasing firm value. However, other studies have not demonstrated a clear relationship between firm age (*FIRM_AGE*) or reputation and firm value.

Business risk

Business risk (*RISK*), often measured by the volatility of operating income, is expected to have a negative impact on firm value. Higher uncertainty in operating cash flows increases the cost of capital demanded by investors, leading to lower firm valuations. Additionally, high business risk increases the probability and cost of expected financial distress, an element that erodes value according to dynamic trade-off theory (Gruber & Warner, 1977; Altman, 1984). It can also limit a firm's borrowing capacity, affecting its optimal capital structure and tax shield benefits (Castanias, 1983). In this study, business risk is the standard deviation of *ROA* calculated over a rolling window of k years ($k = 3$ or $k = 5$) preceding the observation year. This approach is consistent with practices in many previous empirical studies (Titman & Wessels, 1988; Graham, 1996; John et al., 2008). The author chose $k = 3$.

$$RISK_{it} = \frac{\sqrt{\frac{\sum_{j=1}^{k}(ROA_{i(t-j)} - \frac{\sum_{j=1}^{k} ROA_{i(t-j)}}{k})^2}{k-1}}}{\frac{\sum_{j=1}^{k} ROA_{i(t-j)}}{k}} \tag{7}$$

Table 1. Summary of variables and their measurements in the research model

Variable	*Symbol*	*Measurement*	*Reference source*
Firm value	*TobinsQ*	(Market value of equity + Book value of debt) / Book value of total assets	Singh and Bansal (2016), Aggarwal and Padhan (2017), Vega Zavala and Santillán-Salgado (2019), Nguyen (2025)
Capital structure	*DA*	Total liabilities / Total assets	Shen (2017), Cheng et al. (2010), Nieh et al. (2008), Olajide et al. (2017), Vijayakumaran (2017), Chadha and Sharma (2015)
Return on assets	*ROA*	Net income / Total assets	Lang and Stulz (1994), McConnell and Servaes (1995), Demsetz and Villalonga (2001)
Firm size	*Size*	Ln (Total assets)	Abor (2005), Aggarwal and Padhan (2017), Ahmad et al. (2012), Sinebe (2024)
Revenue growth	*GROW*	(Current year's revenue – Previous year's revenue) / Previous year's revenue	Aggarwal and Padhan (2017), Lang and Stulz (1994), McConnell and Servaes (1995)
Asset tangibility	*TANG*	Tangible fixed assets / Total assets	Alathamneh et al. (2025), Berger and Ofek (1995)
Firm age	*FIRM_AGE*	Ln (Number of years of operation)	Diamond (1989), Jovanovic (1982)
Business risk	*RISK*	δROA	Titman and Wessels (1988), Graham (1996), John et al. (2008)

Source: Author's compilation.

3.3.4. Research models

The authors propose three research models corresponding to 1, 2, and 3 capital structure thresholds [see Eqs. (8)–(10)]. The appropriate model will be selected based on statistical tests, where I is the indicator function, and the thresholds are ordered such that $\gamma_1 < \gamma_2 < \gamma_3$. The models are specified as follows.

Single-threshold model

$$TobinsQ_{it} = \mu_i + \beta_1 DA_{it} I(DA_{it} \le \gamma) + \beta_2 DA_{it} I(DA_{it} > \gamma) + \theta_1 ROA_{it} + \theta_2 SIZE_{it} + \theta_3 GROW_{it} + \theta_4 TANG_{it} + \theta_5 FIRM\_AGE_{it} + \theta_6 RISK_{it} + \varepsilon_{it} \quad (8)$$

Double-threshold model

$$TobinsQ_{it} = \mu_i + \beta_1 DA_{it} I(DA_{it} \le \gamma_1) + \beta_2 DA_{it} I(\gamma_1 < DA_{it} \le \gamma_2) + \beta_3 DA_{it} I(DA_{it} > \gamma_2) + \theta_1 ROA_{it} + \theta_2 SIZE_{it} + \theta_3 GROW_{it} + \theta_4 TANG_{it} + \theta_5 FIRM\_AGE_{it} + \theta_6 RISK_{it} + \varepsilon_{it} \quad (9)$$

Triple-threshold model

$$TobinsQ_{it} = \mu_i + \beta_1 DA_{it} I(DA_{it} \le \gamma_1) + \beta_2 DA_{it} I(\gamma_1 < DA_{it} \le \gamma_2) + \beta_3 DA_{it} I(\gamma_2 < DA_{it} \le \gamma_3) + \beta_4 DA_{it} I(DA_{it} > \gamma_3) + \theta_1 ROA_{it} + \theta_2 SIZE_{it} + \theta_3 GROW_{it} + \theta_4 TANG_{it} + \theta_5 FIRM\_AGE_{it} + \theta_6 RISK_{it} + \varepsilon_{it} \quad (10)$$

4. RESULTS AND DISCUSSION

4.1. Descriptive statistics

The descriptive statistics show that the average *TobinsQ* is 1.07, indicating that most listed real estate firms are valued by the market at a premium to their book value. The average *DA* is high at approximately 51%, reflecting the significant use of financial leverage in the industry. The *ROA* variable has a low mean (0.0042), suggesting that overall profitability in the sector is limited. Additionally, the average *SIZE* is relatively large, while the high standard deviations for *GROW* and *RISK* indicate considerable heterogeneity among firms in terms of growth and risk.

Table 2. Descriptive statistics of model variables

Variable	*Obs.*	*Mean*	*Std. dev.*	*Min*	*Max*
TobinsQ	480	1.071713	0.5675849	0.2099221	6.140105
DA	480	0.5099566	0.1849274	0.0031585	0.876001
ROA	480	0.00417117	0.00628676	-0.483408	0.319889
SIZE	480	15.13954	1.559403	11.97175	20.54798
GROW	480	0.7278122	6.373036	-0.9933	126.2655
TANG	480	0.0623211	0.1030573	0.0000187	0.6117589
FIRM_AGE	480	3.011262	0.4381092	1.098612	3.970292
RISK	480	0.242299	0.0336128	0.0000134	0.2763128

Source: Authors' results from Stata 17 analysis.

4.2. Multicollinearity test

To assess potential multicollinearity among the variables, we first examined the correlation coefficients between the explanatory variables and the dependent variable, as presented in the correlation matrix. According to Wooldridge (2016), multicollinearity may be a concern when the correlation coefficient exceeds 0.7. The results reported in Table 3 indicate that no pair of variables exhibits a high correlation, suggesting that multicollinearity is not a serious issue in our estimations. Secondly, we perform a variance inflation factor (VIF) test to further assess the presence of multicollinearity among the independent variables. Nachane (2006) suggests that a VIF value below 10.0 is generally acceptable. As reported in Table 3, the highest VIF is 1.17, indicating a low degree of multicollinearity. Therefore, multicollinearity does not appear to pose a concern in this study.

Table 3. Correlation matrix

Variable	*TobinsQ*	*DA*	*ROA*	*SIZE*	*GROW*	*TANG*	*FIRM_AGE*	*RISK*	*VIF*
TobinsQ	1.0000								
DA	0.1431	1.0000							1.17
ROA	0.1096	-0.2189	1.0000						1.09
SIZE	0.2061	0.2898	-0.0424	1.0000					1.17
GROW	-0.0284	-0.0693	0.1155	-0.0600	1.0000				1.04
TANG	0.0187	0.0721	0.0349	0.0346	-0.0354	1.0000			1.05
FIRM_AGE	0.0657	0.1391	-0.0419	0.1410	-0.0240	0.1964	1.0000		1.11
RISK	0.0943	-0.1320	-0.0937	-0.2391	0.1361	-0.0524	0.1303	1.0000	1.15

Source: Authors' results from Stata 17 analysis.

4.3. Cross-sectional dependence and stationarity tests

4.3.1. Cross-sectional dependence test results

Pesaran (2004) argues for the necessity of testing for cross-sectional correlation and slope heterogeneity in panel data, as individual panel units may have unique characteristics that cause regression coefficients to vary across them. This study uses Pesaran's (2004) cluster of differentiation test, which yielded a p-value of 0.000. Therefore, H_0 is rejected, confirming the presence of cross-sectional dependence in the research data.

4.3.2. Stationarity test results

Variables in a threshold regression model must be stationary to avoid spurious regression (Hansen, 1999, 2000). According to Wang et al. (2020), the cross-sectional augmented Im, Pesaran, and Shin (CIPS) unit root test is appropriate in the presence of cross-sectional dependence, making its results suitable and reliable for this dataset.

All variables in the threshold regression model are stationary at the level. Thus, they are suitable for inclusion in the threshold model for further analysis.

Table 4. CIPS unit root test results

Variable	*Level (CIPS)*	*Conclusion*
TobinsQ	-1.838	*I*(0)
DA	-1.609	*I*(0)
ROA	-1.833	*I*(0)
SIZE	-2.582	*I*(0)
GROW	-2.689	*I*(0)
TANG	-2.166	*I*(0)
FIRM_AGE	-2.157	*I*(0)
RISK	-1.841	*I*(0)

Note: Critical values (10%; 5%; 1%) = 1.45; -1.55; -1.73.
Source: Authors' results from Stata 17 analysis.

4.4. Threshold regression model

4.4.1. Test for threshold effects

This study uses OLS to estimate the thresholds and the Bootstrap method to simulate the likelihood ratio test (LRT) to calculate the F-statistics and p-values for the existence of thresholds. Three tests were conducted:

- for a single threshold (F1);
- for a double threshold (F2);
- for a triple threshold (F3).

The hypotheses for these tests are shown in Table 5.

Table 5. Hypotheses for threshold effect tests

No.	*Symbol*	*Test*	*Null hypothesis (H_0)*	*Alternative hypothesis (H1)*
1	F1	Single threshold test	No threshold effect exists	A single threshold effect exists
2	F2	Double threshold test	A single threshold effect exists	A double threshold effect exists
3	F3	Triple threshold test	A double threshold effect exists	A triple threshold effect exists

Source: Authors' compilation.

Each test was performed using 1.000 bootstrap replications. The F-statistics and p-values are presented in Table 6.

The F-statistic for F1 is 20.12, which is greater than the 5% critical value (11.7324), with a p-value of 0.008. This is statistically significant, so H_0 is rejected, confirming the existence of at least one threshold.

Next, the test for F2 yields an F-statistic of 17.31 with a p-value of 0.013. This is also significant at the 5% level. Therefore, hypothesis H_0 (a single threshold effect exists) is rejected, indicating the existence of two thresholds.

Finally, the test for F3 results in an F-statistic of 10.05 with a p-value of 0.152. This is not statistically significant at the 5% level. Therefore, we fail to reject H_0 and conclude that the model has two thresholds (Hansen, 2000).

Although the F1 is statistically significant, indicating the existence of at least one threshold, the subsequent F2 is also significant at the 5% level. This result implies that a model with only one threshold is statistically insufficient and is rejected. Following the sequential testing procedure proposed by Hansen (1999), the rejection of H_0 in the F2 test provides evidence in favor of a double-threshold specification. Therefore, the double-threshold model is preferred, as it better captures the non-linear relationship between *DA* and *TobinsQ*.

Table 6. Results of threshold effect tests

Test	*Threshold value*	*F-statistics*		*Critical values of F*		
		F	*p-value*	*1%*	*5%*	*10%*
F1	0.4524	20.12	0.008	16.3867	11.7324	9.4572
F2	0.4514 0.5618	17.31	0.013	15.9876	10.8712	9.1203
F3	0.3540	10.05	0.152	20.4739	13.3075	10.9098

Source: Authors' results from Stata 17 analysis.

4.4.2. Threshold regression estimation results

The analysis above confirms a double-threshold effect. The estimated threshold values are 45.14% and 56.18%, which divide the sample into three regimes: *DA* below 45.14%, *DA* between 45.14% and 56.18%, and *DA* above 56.18%. The OLS estimation results for the threshold model are shown in Table 6.

Table 7. Estimation results of the threshold model coefficients

Variable	*Coefficient*	*Std. err.*	*T*	*p > |t|*
Dependent variable: TobinsQ				
RISK	-2.1593	0.831535	-2.60	0.010
TANG	-0.3097208	0.3674753	-0.84	0.400
ROA	0.9924651	0.4270836	2.32	0.021
GROW	0.0010256	0.0032483	0.32	0.752
FIRM_AGE	0.6978308	0.198986	3.51	0.000
SIZE	-0.2598496	0.0680362	-3.82	0.000
_cons	2.437714	0.8737348	2.79	0.006
Independent variable: DA				
0	3.008248	0.5344979	5.63	0.000
1	2.203082	0.3365782	6.55	0.000
2	-1.749288	0.2658061	-6.58	0.000
Rho	0.81451637			
F (9, 411) = 8.01; Prob > F = 0.0000 corr(u_i, Xb) = 0.8269; R^2 = 0.1705				

Source: Authors' results from Stata 17 analysis.

Overall, the model is statistically significant, with an F-statistic of 8.01 (p = 0.000), indicating that the explanatory variables collectively have a significant impact on *TobinsQ*. The R^2 value of 0.1705 indicates that the model explains approximately 17.05% of the variation in *TobinsQ* within firms over time. The rho value of 0.8145 suggests that approximately 81.45% of the variance in *TobinsQ* is due to differences between firms, justifying the use of a fixed-effects model. The regression results show that *ROA*, *FIRM_AGE*, and *RISK* have a significant impact on *TobinsQ* at the5% level, while *SIZE* is significant at the 1% level. *TANG* and *GROW* do not show a statistically significant effect.

On the capital structure variable (*DA*):

- Regime 1 (*DA* ≤ 45.14%): In this first regime, *DA* has the strongest positive impact on *TobinsQ* (β = 3.0082, p = 0.000). This suggests that when the debt ratio is below 45.14%, an increase in debt enhances *TobinsQ*. This is the "safe" borrowing range where firms can effectively leverage the tax shield and financial discipline benefits without facing significant pressure from debt service costs. In the capital-intensive and long-cycle real estate industry, this level of debt helps maintain stable cash flow and project progress.
- Regime 2 (45.14% < *DA* ≤ 56.18%): A similar positive relationship exists in the second regime, but the effect diminishes (β = 2.2031, p = 0.000). Although firms still benefit from financial leverage, the rising costs of debt (interest expenses, administrative costs of managing multiple loans) begin to offset the benefits, leading to a smaller positive impact on *TobinsQ*.
- Regime 3 (*DA* > 56.18%): In the third regime, the relationship turns negative and significant (β = -1.7493, p = 0.000). When the debt ratio exceeds 56.18%, further increases in debt reduce *TobinsQ*. This is because excessive leverage in the Vietnamese real estate sector leads to high debt service pressure, increased risk of insolvency, potential project delays, and eroded investor confidence. Agency costs (between shareholders and creditors) also rise, and financial flexibility is lost, ultimately diminishing *TobinsQ*. This result implies that the optimal *DA* threshold for listed real estate firms is 56.18%, and firms should be cautious about exceeding this level.

On control variables:

- *ROA*: The positive and significant coefficient (β = 0.9925, p = 0.021) aligns with theoretical expectations. Higher profitability signals financial strength and sustainable cash flow generation, boosting investor confidence and firm valuation. This is consistent with Lang and Stulz (1994), McConnell and Servaes (1995), and Demsetz and Villalonga (2001).
- *FIRM_AGE*: The variable has a positive and significant impact on *TobinsQ* (β = 0.6978308, p = 0.000). Older firms are valued more highly due to their established reputation, managerial experience, stable financial relationships, and proven ability to navigate economic cycles. In the real estate sector, age also reflects advantages in land access and project permitting, which are critical in the Vietnamese context. This is consistent with Diamond (1989) and Jovanovic (1982).
- *SIZE*: Conversely, *SIZE* has a negative and significant impact on *TobinsQ* (β = -0.2598, p = 0.000). This suggests that larger firms are not necessarily valued more highly, possibly due to operational inefficiencies, reduced flexibility, or limited growth potential. This finding raises interesting questions about the "scale effect" in the studied market and is consistent with Sinebe (2024).
- *RISK: RISK* has a negative impact on *TobinsQ* (β = -2.1593, p = 0.010). This is consistent with agency theory and trade-off theory, as higher risk increases agency costs and the probability of financial distress, thereby lowering market expectations of *TobinsQ* (Jensen & Meckling, 1976). This aligns with Titman and Wessels (1988), Graham (1996), and John et al. (2008).
- *TANG* and *GROW*: *TANG* and growth rate show no statistically significant impact on *TobinsQ*. This may suggest that for Vietnamese real estate firms, tangible assets are not a primary driver of value, and growth does not always translate to higher value if it is not accompanied by efficiency.

The final estimated model is:

$$TobinsQ_{it} = 2.437714 + 3.008248\, DA_{it} I(DA_{it} \leq 0.4514) + 2.203082\, DA_{it} I(0.4514 < DA_{it} \leq 0.5618) \\ -1.749288\, DA_{it} I(DA_{it} > 0.5618) + 0.9924651\, ROA_{it} - 0.2598496\, SIZE_{it} + 0.0716142\, FIRM\_AGE_{it} \\ -2.1593\, Risk_{it} + \varepsilon_{it} \quad (11)$$

Table 8 shows that 42.7% of observations fall into the highest debt regime (*DA* > 0.5618), where increased leverage tends to decrease *TobinsQ*. This reflects the common practice of high leverage among listed real estate companies in Vietnam. Maintaining a *DA* beyond the optimal threshold not only increases financial risk but also presents a tangible threat of market value erosion, especially as the real estate market faces pressure from credit control policies and tighter corporate bond regulations.

Table 8. Number of observations in each regime by year

Year	*DA ≤ 0.4514*	*0.4514 < DA ≤ 0.5618*	*DA > 0.5618*	*Total*
2017	24	11	25	60
2018	21	11	28	60
2019	21	11	28	60
2020	17	14	29	60
2021	21	17	22	60
2022	20	14	26	60
2023	24	12	24	60
2024	20	17	23	60
Total	168 (35%)	107 (22.3%)	205 (42.7%)	480 (100%)

Source: Authors' results from Stata 17 analysis.

4.5. Discussion of the results

This study empirically examines the nonlinear relationship between capital structure and firm value for listed real estate firms in Vietnam using the panel threshold regression model of Hansen (1999). By employing a panel threshold regression framework, the findings reveal that the impact of leverage on firm value is regime-dependent, confirming that the effect of debt varies across different leverage levels rather than remaining constant.

Specifically, when the debt ratio is below 45.14%, leverage exerts a positive effect and enhances firm value, which is consistent with the tax-shield argument of Modigliani and Miller (1963), which suggests that moderate debt usage allows firms to benefit from tax shields and enhanced managerial discipline while maintaining financial stability. In the context of the Vietnamese real estate sector—characterized by high capital intensity and long project cycles—moderate leverage helps firms sustain cash flows and ensure project continuity without imposing excessive financial pressure. When the debt ratio lies between 45.14% and 56.18%, the positive impact of leverage gradually weakens. This finding indicates that the marginal benefits of additional debt begin to decline as firms face higher interest expenses, refinancing costs, and increased complexity in debt management. Although leverage continues to play a supportive role in firm value creation within this intermediate regime, the rising costs gradually offset its advantages. However, once the debt ratio exceeds 56.18%, leverage begins to exert a negative effect on firm value. This regime reflects a situation in which excessive debt intensifies financial distress risk, reduces financial flexibility, and amplifies agency conflicts between shareholders and creditors. In the Vietnamese real estate market, high leverage is often associated with delayed projects, liquidity constraints, and declining investor confidence, all of which undermine firm value. This result underscores the importance of maintaining leverage within an optimal range to avoid value destruction. These findings are in line with previous studies documenting a nonlinear or inverted U-shaped relationship between leverage and firm value, such as Shen (2017) and Ghosh (2008), and particularly those employing threshold models including Hansen (1999), Cheng et al. (2010), Lin and Chang (2011), and Duc and Luan (2014), all of which highlight the existence of an optimal leverage level and the reversal of effects once firms exceed this optimal debt threshold.

Overall, the findings align with and extend prior studies by demonstrating the relevance of threshold effects in capital structure decisions, particularly in emerging markets where financial constraints and institutional factors play a critical role.

5. CONCLUSION

This study examines the non-linear impact of capital structure on firm value for listed real estate companies in Vietnam using a panel threshold regression model. Based on a balanced panel of 60 firms over the period 2017–2024, the results provide strong evidence of a double-threshold effect in the relationship between leverage and firm value. The findings indicate that debt enhances firm value at low leverage levels, yields diminishing benefits at moderate levels, and becomes value-destroying when leverage exceeds a critical threshold.

These results offer important implications for corporate financial decision-making. In particular, capital structure should be managed dynamically rather than based on a uniform leverage target. The identified leverage threshold may serve as a practical reference point for managers, as maintaining debt within an optimal range helps balance the benefits of leverage against rising financial distress and agency costs. The findings also suggest that firm value in the real estate sector is driven more by profitability and risk management than by scale expansion alone, highlighting the importance of financial discipline and efficient project selection.

From an investment and policy perspective, the results underscore the importance of monitoring leverage levels in the real estate sector, which is highly sensitive to macroeconomic conditions and financing constraints. Excessive reliance on debt financing may amplify firm-level and systemic risks, reinforcing the need for prudent credit supervision and the development of more diversified, long-term financing channels.

Despite its contributions, this study has several limitations. The use of a balanced panel may introduce sample selection bias by excluding firms with incomplete data, potentially limiting the generalizability of the results. In addition, the analysis focuses on specific measures of leverage and firm value and is confined to the Vietnamese real estate sector. Future research may address these limitations by employing unbalanced panels, alternative leverage and risk measures, dynamic threshold models, or cross-country analyses to further explore capital structure thresholds and firm value.

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