International Journal of Education, Business and Economics Research (IJEBER)

ISSN: 2583-3006

Vol. 5, Issue 3, May-June 2025, pp 360-370

To cite this article: Thi Thu Hang Nguyen (2025). Theoretical Framework Of Capital Structure Threshold And The Impact Model Of Capital Structure Threshold On The Firm Value Of Listed Companies In Vietnam. International Journal of Education, Business and Economics Research (IJEBER) 5 (3): 360-370

THEORETICAL FRAMEWORK OF CAPITAL STRUCTURE THRESHOLD AND THE IMPACT MODEL OF CAPITAL STRUCTURE THRESHOLD ON THE FIRM VALUE OF LISTED COMPANIES IN VIETNAM

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https://doi.org/10.59822/IJEBER.2025.5318

ABSTRACT

This study focuses on establishing the theoretical foundation for the concept of capital structure thresholds. By synthesizing key financial theories and prior empirical studies, the paper explains the existence of threshold effects in the relationship between capital structure and firm value. It argues that the impact of financial leverage on firm value may vary across different levels of debt. At low levels of leverage, the effect may be positive due to the tax shield benefits; however, beyond a certain threshold, rising financial costs and bankruptcy risks may outweigh the benefits, thereby reducing firm value. The core of the study presents the threshold regression model developed by Hansen (1999), detailing the procedures for estimating the threshold value, conducting statistical inference, and extending the model to multiple thresholds. Capital structure serves as the primary threshold variable. The study proposes applying this model to listed firms in Vietnam, offering a direction for future empirical research to test the existence of such thresholds and identify the optimal level of capital structure for Vietnamese firms.

KEYWORDS: - Capital structure threshold, firm value, threshold model.

1.0 INTRODUCTION

Capital structure, defined as the mix of debt and equity that a firm employs to finance its assets, operations, and growth, represents a critical strategic decision for businesses. The selection of an optimal capital structure is essential as it significantly influences the cost of capital, the level of

financial risk, and ultimately the overall firm value and its long-term sustainable development (Almajali, Alamro, & Al-Soub, 2012). Decisions related to capital structure require careful consideration of the trade-offs between the benefits and costs associated with the use of debt and equity. One of the key indicators used to assess capital structure is the debt-to-equity ratio or the debt-to-asset ratio, calculated by dividing total liabilities by either total equity or total assets. These ratios provide insight into the extent of financial leverage a firm utilizes in its financing activities.
Understanding the relationship between capital structure and firm value (FV) is of paramount importance. However, assuming a simple linear relationship between these two variables may be insufficient to capture their inherent complexity. Numerous studies have suggested that this relationship may be non-linear, with varying effects at different levels of leverage. There may exist "thresholds" in the capital structure where the impact of leverage on firm value changes significantly once a certain level of debt or equity is surpassed. These thresholds could arise due to the trade-off between the tax advantages of debt and the increasing costs associated with financial risk (Lin & Chang, 2011). The capital structure threshold hypothesis posits that exceeding a certain debt level could have adverse consequences for firm value due to heightened financial risk and potential financial distress costs. Conversely, maintaining excessively low levels of debt may reflect suboptimal financial leverage, potentially forfeiting tax shield benefits and growth opportunities (Sahoo & Yarso, 2024).

Identifying capital structure thresholds provides managers with a valuable tool to make strategic decisions about their financing policies aimed at maximizing firm value while managing financial risk effectively. Furthermore, investors can utilize this information to more accurately assess the financial risk and profitability potential of a firm based on its capital structure.

Although several studies have explored the impact of capital structure on the firm value of listed companies in Vietnam, most existing research primarily focuses on linear relationships. Therefore, a more in-depth theoretical investigation into the threshold effects of capital structure on the firm value of listed companies in Vietnam is both necessary and timely.

2.0 THEORY OF CAPITAL STRUCTURE THRESHOLDS

2.1 The Concept of Threshold Effect

In economics and finance, many relationships are not inherently linear. The effect of one variable on another can vary depending on the current value of the independent variable or on other economic conditions. The concept of a *threshold* is used to describe critical points or levels at which the nature of a relationship undergoes a significant change. Identifying and analyzing such thresholds provides deeper insights into the complex dynamics of corporate financial variables.

A threshold in an economic relationship refers to a *critical value* or a *switching point* of a variable—typically an independent or state variable—at which the structure or parameters of the relationship between variables change. As a result, modeling the relationship with a single linear function across the entire range of values may no longer be appropriate or sufficient. Common types of thresholds include:

- Break Point: This is a point at which the slope of the function describing the relationship changes abruptly. For example, marginal production costs may increase slowly at low output levels but spike sharply beyond a "break point" in capacity due to overtime or less efficient equipment. In econometrics, identifying structural break points in time series or panel data is a major area of research (Hansen, 1999; Bai & Perron, 2003).

- Optimal Point: In nonlinear relationships such as U-shaped or inverted U-shaped curves, the extremum point (minimum or maximum) serves as a threshold. At this point, the effect of the independent variable on the dependent variable reverses. For instance, according to microeconomic theory, average cost typically follows a U-shaped pattern, with the minimum point representing the most cost-efficient level of output. Similarly, the risk-return relationship may initially exhibit increasing returns with rising risk, but beyond a certain risk threshold, returns may begin to decline sharply.

- Regime Switching: This broader concept refers to situations in which the entire model characterizing the relationship changes once a state variable crosses a threshold. Regression coefficients may vary entirely across different regimes. For example, consumer behavior may differ significantly during a recession compared to a period of economic expansion—implying regime switching based on macroeconomic conditions. Hansen's (1999) *threshold regression model* is an econometric technique specifically designed to identify such thresholds and estimate different regression coefficients for distinct regimes based on the data.

In econometric analysis, the threshold effect describes a specific type of nonlinear relationship in which the influence of an explanatory variable (X) on a dependent variable (Y) fundamentally changes when a threshold variable exceeds one or more critical values (denoted as γ). Rather than imposing a fixed (e.g., linear) relationship across the entire data range, threshold models allow for the existence of distinct *regimes*, each with its own set of impact coefficients (Tong, 1990; Hansen, 1999).

In this study, the effect of an increase in the debt ratio on firm value, may be positive at low levels of debt, but could become negative once the debt ratio exceeds a certain threshold level γ. Identifying and modeling threshold effects thus enables a better understanding of complex real-world relationships and helps avoid misleading conclusions that may arise from oversimplified linear modeling.

2.2 Theoretical Foundations for the Existence of Thresholds in the Capital Structure–Firm Value Relationship

The expectation of a threshold effect in the relationship between capital structure (leverage) and firm value is grounded in the synthesis of several capital structure theories, particularly those that emphasize the trade-offs between the benefits and costs of debt:

- Trade-off Theory Perspective (Dynamic Equilibrium Framework): This serves as the primary theoretical foundation.

Low-Debt Regime (Below Threshold): When a firm maintains a relatively low level of debt, the tax shield benefits from interest deductibility are substantial and positively affect firm value. At this level of leverage, the probability of financial distress is minimal, making the expected cost of financial distress (including both direct and indirect costs) nearly negligible. In this regime, the marginal benefits of debt outweigh the marginal costs. Therefore, the derivative of firm value with respect to debt is positive: ΔFirm Value / ΔDebt > 0.

High-Debt Regime (Above Threshold): As the debt ratio surpasses a certain threshold, the probability of default increases significantly. Consequently, the expected cost of financial distress escalates rapidly. Although the tax shield remains present, the marginal cost associated with financial distress begins to outweigh the marginal benefit of debt. In this scenario, additional borrowing results in a decline in firm value: ΔFirm Value / ΔDebt < 0.

Threshold Point (γ): This is the level of leverage at which the marginal benefit of debt equals its marginal cost. It corresponds to the optimal debt level in the static trade-off framework—where firm value reaches its maximum.

- Agency Cost Theory Perspective:

Reduced Equity Agency Costs (Low Debt): An initial increase in debt may mitigate agency problems between managers and shareholders by imposing financial discipline and reducing free cash flows (Jensen, 1986), thereby enhancing firm value.

Increased Debt Agency Costs (High Debt): When leverage becomes excessive, agency conflicts between shareholders and creditors become more severe—manifesting in risk-shifting behaviors and underinvestment. These agency costs add to the expected financial distress costs, reinforcing the negative effect of debt in the high-debt regime.

- Additional Factors Reinforcing the Threshold Effect:

Information Asymmetry: Excessive debt may be interpreted by the market as a negative signal, increasing the firm's cost of capital.

Loss of Financial Flexibility: At high leverage levels, strict debt covenants can limit the firm’s responsiveness and investment capacity.

In summary, the interplay between the benefits of debt (e.g., tax shield, managerial discipline) and its associated costs (e.g., financial distress, agency problems, reduced flexibility) gives rise to a non-linear, likely inverted U-shaped relationship between leverage and firm value, with a critical turning point—i.e., the threshold—at which the relationship reverses.

2.3 Empirical Studies on the Threshold Effect of Capital Structure on Firm Value

Several empirical studies have concluded that firm performance is related to capital structure in a quadratic or cubic functional form. Xu, Xu, and Zhang (2005) indicated that firm performance is significantly influenced by capital structure. Specifically, firm performance is inversely related to capital structure when the debt ratio exceeds 37.6%, while the opposite effect is observed when the debt ratio is below 37.6%. Ghosh (2008), in studying the effects of dividend policy, financial leverage, and profitability on firm value, found a quadratic relationship between financial leverage and the future value of the firm.

Some studies have particularly investigated the existence of thresholds in the relationship between capital structure and firm value. These studies applied the panel threshold regression model developed by Hansen (1999) to identify the points at which the impact of leverage on firm value changes significantly. Cheng, Liu, and Chien (2010) employed the threshold regression technique to examine the threshold effect of the debt-to-total-assets ratio on firm value using data from 650 listed companies over the period 2001–2006. The study identified three distinct thresholds of the debt ratio that yielded different effects on firm value. When the debt ratio was below 53.97%, the impact was positive, indicating that increasing debt improved firm value. When the debt ratio ranged from 53.97% to 70.48%, the positive impact remained but began to diminish. However, when the ratio was between 70.48% and 75.26% or exceeded 75.26%, the effect turned negative, implying a sharp decline in firm value with further increases in debt. Nieh, Yau, and Liu (2008) examined the existence of an optimal debt ratio and found that, for electric utility companies listed in Taiwan, the optimal debt level should lie between 12.37% and 28.70%, while exceeding 51.57% or falling below 12.37% was deemed inappropriate for maintaining or enhancing firm value. Lin and Chang (2011), in their study of Taiwanese firms, identified two thresholds of the debt-to-equity ratio at 9.86% and 33.33%. Below 9.86%, increased debt enhanced firm value; between 9.86% and 33.33%, the effect was still positive but weaker; and above 33.33%, no significant relationship was found.

In Vietnam, several studies have also reported a nonlinear relationship between capital structure and firm value, suggesting the presence of threshold effects. Cuong (2014), using data from 2005 to 2011 for seafood processing firms, found a cubic threshold effect when using the book value of equity plus long-term debt (BVE) as a proxy for firm value, and a quadratic effect when using ROE. Quynh (2024), using data from 2017 to 2022 for real estate companies, identified a quadratic relationship between capital structure and firm value, indicating the existence of an optimal leverage level. Long (2018) examined both general and maturity-specific capital structure effects on firm value for listed joint-stock companies on the Ho Chi Minh Stock Exchange (HSX). Using the GMM estimation method, the study found threshold effects for total debt, short-term debt, and long-term debt ratios at 67.86%, 45.45%, and 25.98%, respectively. Increases in the total debt ratio and short-term debt ratio led to increases in firm value but only up to their respective thresholds, beyond which the effect became negative. In contrast, an increase in the long-term debt ratio only had a positive effect if it exceeded the threshold. The diversity of empirical results in Vietnam illustrates the complexity of the relationship between capital structure and firm value, as well as the influence of various other factors. Duc and Luan (2014) investigated the optimal debt usage threshold for listed firms in Vietnam by examining the impact of debt usage on profitability using data from 191 companies listed on the Ho Chi Minh City and Hanoi Stock Exchanges during the period 2005–2012. The study found two key thresholds in the relationship between debt usage and profitability. Specifically, (i) debt usage had a positive effect on profitability when the debt ratio was below 56.67%; (ii) when the debt ratio ranged between 56.67% and 69.72%, the effect turned negative; and (iii) when the ratio exceeded 69.72%, the negative impact became increasingly severe.

3.0 THRESHOLD REGRESSION MODELS OF CAPITAL STRUCTURE ON FIRM VALUE

To test and estimate the threshold effect in empirical data, threshold regression models have been developed. These models allow the relationship between the dependent variable and the explanatory variable(s) to vary across different regimes. The model automatically identifies one (or more) threshold value(s) (γ) for the threshold variable, and estimates separate regression coefficients for the subsamples divided by this threshold.

3.1. Panel Threshold Regression (PTR) Model by Hansen (1999, 2000)

The threshold regression method introduced by Hansen (1999) enables the identification of one or more threshold values of a variable (typically a capital structure indicator or another state variable), at which the coefficient of the main independent variable (usually capital structure) on the dependent variable (firm value/performance) changes in a statistically significant manner.

Unlike models that simply add a squared term (which only test for a specific nonlinear form such as a U-shape or inverse U-shape), the threshold model precisely estimates the threshold value(s) and tests for differences in impact between the "regimes" divided by these thresholds.

3.1.1 Single-Threshold Model

According to Hansen (1999; 2000), the threshold regression model is constructed based on balanced panel data ($y_{it}, q_{it}, x_{it}: 1 \leq i \leq$ n,$1 \leq t \leq T$), where i denotes the cross-sectional unit, t denotes the time period, y_{it} is the dependent variable, q_{it} is the threshold variable, and x_{it} is the vector of independent variables. A single-threshold model can be expressed as follows:

$$y_{it} = \mu_i + \beta'_1 x_{it} I(q_{it} \leq \gamma) + \beta'_2 x_{it} I(q_{it} > \gamma) + e_{it} \quad (1)$$

With I being the objective function, equation (1) can be rewritten as follows:

$$y_{it} = \begin{cases} \mu_i + \beta'_1 x_{it} + e_{it} & \text{nếu} \quad q_{it} \leq \gamma \\ \mu_i + \beta'_2 x_{it} + e_{it} & \text{nếu} \quad q_{it} > \gamma \end{cases}$$

Let $\beta' = (\beta'_1, \beta'_2)$. then, equation (1) is equivalent to:

$$y_{it} = \mu_i + \beta' x_{it}(\gamma) + e_{it} \quad (2)$$

In this case, the threshold value γ divides the sample into two groups, corresponding to the threshold variable q_{it} being greater than and less than or equal to γ. These two groups can be represented by different coefficient matrices β_1 and β_2. The error term e_{it} is assumed to follow a normal distribution with a mean of 0 and variance σ^2.

3.1.2 Estimation Method for Threshold and Coefficients in the Model

Threshold estimation (γ): According to Hansen (1999), the threshold value γ is estimated by minimizing the sum of squared residuals (SSR) through grid search, and the coefficients β of the model are estimated using the ordinary least squares (OLS) method. To perform the estimation, it is necessary to determine the average of equation (1) by time period index t:

$$\overline{y_t} = \mu_i + \beta'\overline{x_t}(\gamma) + \overline{e_t} \text{ (3)}$$

With: $\overline{y_t} = T^{-1}\sum_{t=1}^{T} y_{it}$

$$\overline{e_t} = T^{-1}\sum_{t=1}^{T} e_{it}$$

$$\overline{x_t}(\gamma) = T^{-1}\sum_{t=1}^{T} x_{it}\,(\gamma)$$

Take the difference of equations (2) and (3).

$$y_t^* = \beta' x_t^*(\gamma) + e_t^* \text{ (4)}$$

With: $y_t^* = y_{it} - \overline{y_t}$

$$e_t^* = e_{it} - \overline{e_t}$$

$$x_{it}^*(\gamma) = x_{it}(\gamma) - \overline{x}_i(\gamma)$$

The new equation is expressed as: Create matrices based on the calculated values:

$$y_i^* = \begin{bmatrix} y_{i1} \\ \vdots \\ y_{iT} \end{bmatrix} \quad x_i^*(\gamma) = \begin{bmatrix} x_{i1}^*(\gamma) \\ \vdots \\ x_{iT}^*(\gamma) \end{bmatrix} \quad e_i^* = \begin{bmatrix} e_{i1} \\ \vdots \\ e_{iT} \end{bmatrix}$$

$$Y^* = \begin{bmatrix} y_1^* \\ \vdots \\ y_n^* \end{bmatrix} \quad X^*(\gamma) = \begin{bmatrix} x_1^*(\gamma) \\ \vdots \\ x_n^*(\gamma) \end{bmatrix} \quad e^* = \begin{bmatrix} e_1^* \\ \vdots \\ e_n^* \end{bmatrix}$$

Equation (4) is equivalent to:

$$Y^* = X^*(\gamma)\beta + e^* \text{ (5)}$$

For each threshold value γ, the coefficient β can be estimated using OLS.

$$\hat{\beta}(\gamma) = \left(X^*(\gamma)'X^*(\gamma)\right)^{-1} X^*(\gamma)'Y^*$$

The residual vector is defined as:

$$\hat{e}^*(\gamma) = Y^* - X^*(\gamma)\hat{\beta}(\gamma)$$

The sum of squared residuals (SSR) is defined as:

$$S_1(\gamma) = \hat{e}^*(\gamma)'\hat{e}^*(\gamma) \text{ (6)}$$

According to Chan (1993) and Hansen (1999), the estimate of the threshold value γ is determined by minimizing the value of $S_1(\gamma)$ in equation (6).

$$\hat{\gamma} = \mathrm{argmin}_{\gamma} S_1(\gamma) \ (7)$$

When the value of $\hat{\gamma}$is determined, $\hat{\beta} = \hat{\beta}(\hat{\gamma})$ và $\hat{e}^* = \hat{e}^*(\hat{\gamma})$.
The variance of the residuals (Residual Variance):

$$\hat{\sigma}^2 = \frac{1}{n(T-1)} S_1(\hat{\gamma})$$

3.1.3 Threshold Testing for the Model

Testing the existence of a threshold: To test the hypothesis H_0: $\beta_1 = \beta_2$ (linear model), an F statistic or LR (Likelihood Ratio) test can be used. Since the threshold value γ is not defined under H_0, the bootstrap method must be employed to compute the p-value (Hansen, 1996, 1999). Specifically:

Once the threshold value γ is identified, the next step is to determine the statistical significance of γ. For the model examined in equation (1), the hypothesis to test the threshold effect of the model is:

$$H_0: \beta_1 = \beta_2$$

If H_0 is accepted, it can be concluded that no threshold effect exists between the variables x_{it} and y_{it} in equation (1), meaning the threshold value γ is undefined. In this case, classical tests will have a non-normal distribution (Hansen, 1999). This issue was studied by Davies (1977) and further developed by Hansen (1996). To test the above hypothesis, Hansen (1996) proposed using the bootstrap method to simulate the Likelihood Ratio Test (LRT) with an asymptotic distribution that converges to the normal distribution.

When there is no threshold effect, equation (1) is equivalent to:

$$y_{it} = \mu_i + \beta_1 x_{it} + e_{it} \ (8)$$

Transforming equation (8) according to the steps in the threshold determination method, equation (9) is obtained:

$$y_i^* = \beta_1^* x_t^*(\gamma) + e_i^* \ (9)$$

From equation (9), the estimated value of β_1 (β_1), the residual vector ($\hat{e}_{it}^*$), *and the sum of squared residuals* ($S_0 = \hat{e}_{it}^*{}'\hat{e}_{it}^*$) are determined.

The likelihood ratio (F_1) is calculated using the following formula:

$$F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2}$$

After performing the bootstrap on the sample, the p-value is also determined. Hansen (1996) argues that this p-value plays a crucial role in deciding whether to accept or reject the null hypothesis H_0. If the p-value is smaller than the critical values, the null hypothesis H_0 is rejected.

3.1.4. Multiple Thresholds Model

If there exist two threshold values γ_1 and γ_2, assuming $\gamma_1 < \gamma_2$the above equation can be rewritten as follows:

$$y_{it} = \mu_i + \beta_1 x_{it} I(q_{it} \leq \gamma_1) + \beta_2 x_{it} I(\gamma_1 < q_{it} \leq \gamma_2) + \beta_3 x_{it} I(q_{it} > \gamma_2) + e_{it}$$

Equivalently:

$$y_{it} = \begin{cases} \mu_i + \beta_1 x_{it} + e_{it} & \text{nếu } q_{it} \leq \gamma_1 \\ \mu_i + \beta_2 x_{it} + e_{it} & \text{nếu } \gamma_1 < q_{it} \leq \gamma_2 \\ \mu_i + \beta_3 x_{it} + e_{it} & \text{nếu } q_{it} > \gamma_2 \end{cases} \quad (10)$$

Similarly, for models with more than two thresholds, the threshold values increase sequentially from $(\gamma_1, \dots, \gamma_n)$

3.2. The Impact Model of Capital Structure Threshold on Firm Value

Single-threshold model case

$$FV_{it} = \mu_i + \beta_1 . CS_{it} I(q_{it} \leq \gamma) + \beta_2 . CS_{it} I(q_{it} > \gamma) + \delta . Controls_{it} + e_{it} \quad (1)$$

Where:

− FV_{it}: The dependent variable, measuring the value of firm *i* at time *t*.
 Primary measure: Tobin's Q.
 Alternative (robustness) measure: M/B (Market-to-Book Ratio).

− u_i: Firm-fixed effects. These control for unobserved, time-invariant characteristics of each firm that may affect firm value (e.g., corporate culture, inherent management quality).

− CS_{it}: The main independent variable and also the threshold variable, measuring the capital structure of firm *i* at time *t*.
 Primary measure: D/A (Total Debt to Total Assets ratio).
 Alternative (robustness) measure: D/E (Total Debt to Equity ratio).

−γ:: The threshold value of capital structure, to be estimated from the data. This is the point at which the relationship between capital structure and firm value is assumed to change.

−I(.): Indicator function:
 I(CS_{it}≤ γ): Equals 1 if the capital structure of firm *i* at time *t* is less than or equal to the threshold γ, and 0 otherwise.
 I(CS_{it}> γ): Equals 1 if the capital structure is greater than γ, and 0 otherwise.

− β_1: The estimated coefficient of CS_{it} when the threshold variable is less than or equal to the threshold value.
− β_2: The estimated coefficient of CS_{it} when the threshold variable is greater than the threshold value.

− $Controls_{it}$: A vector of control variables for firm *i* at time *t* believed to influence firm value, including (but not limited to):

Profitability (ROA)
Firm size (Ln(Total Assets))
Growth opportunities (Revenue growth or lagged M/B)
Tangibility (ratio of tangible fixed assets)
Firm age (Ln(Age))
Business risk (Volatility of ROA)
Dividend policy (Dividend Payout Ratio or a dummy variable)
(Industry or year dummy variables can also be included if necessary)

− δ: Vector of coefficients corresponding to the control variables.
− e_{it}: The error term, assumed to be independently and identically distributed: $e_{it} \sim iid(0, \sigma^2)$.
− i: Firm index.
− t: Time index.

Expected Signs of Threshold Coefficients:
Based on the Dynamic Trade-off Theory, the main expectations are:
− β_1 may be positive (or statistically insignificant if the benefits of tax shields are unclear at very low debt levels).

− β_2 is expected to be negative and statistically significant, suggesting that when leverage exceeds the threshold, financial distress and other costs outweigh the benefits, thereby reducing firm value.

− A statistically significant difference between β_1 and β_1 is expected.

The model can also be extended to test for multiple thresholds if there is theoretical justification and preliminary empirical evidence supporting such nonlinearity. However, a single-threshold model is typically a reasonable starting point.

Two-threshold model case

$$FV_{it} = \mu_i + \beta_1.CS_{it}I(q_{it} \leq \gamma_1) + \beta_2.CS_{it}I(\gamma_1 < q_{it} \leq \gamma_2) + \beta_3.CS_{it}I(q_{it} > \gamma_2) + \delta.Controls_{it} + e_{it}$$

The study proposes applying this model to listed firms in Vietnam, offering a direction for future empirical research to test the existence of such thresholds and identify the optimal level of capital structure for Vietnamese firms.

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