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ALAALI OPTIMAL LEVERAGE MODEL (ALOM): A STRATEGIC FRAMEWORK FOR CAPITAL STRUCTURE OPTIMIZATION

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ABSTRACT

Introduction: Capital structure decisions require firms to balance the financial benefits of debt against default exposure, earnings volatility, liquidity pressure, and changing macro-financial conditions. Although existing capital structure research incorporates dynamic adjustment, default risk, and macroeconomic effects, an opportunity remains for an integrated benefit–risk structure that determines optimal leverage as financial and systemic conditions evolve.
Methods: This study develops the Alaali Optimal Leverage Model (ALOM) as a theoretical and mathematical capital structure model. ALOM begins with a general benefit–risk formulation and develops this logic within a stochastic firm-value setting incorporating continuous volatility, jump risk, leverage-dependent default exposure, and systemic-risk costs. The general dynamic optimization problem is formalized through a Hamilton–Jacobi–Bellman (HJB) structure. Under explicitly simplifying assumptions, including the exclusion of jump risk, a reduced-form leverage target and partial-adjustment mechanism are specified separately to represent gradual convergence toward a condition-dependent target. The model is examined through comparative statics, numerical illustration, and illustrative financial scenarios.
Results: The theoretical results indicate that the attractiveness of leverage increases with the economic benefits of debt and decreases as earnings volatility, systemic risk, and expected distress costs increase. Under the simplified no-jump specification, the leverage target decreases with volatility and distress costs, while the partial-adjustment mechanism predicts gradual rather than instantaneous convergence toward that target when adjustment frictions are present. The full stochastic specification additionally captures the effect of discontinuous systemic shocks on leverage decisions. Illustrative scenarios demonstrate the directional implications of changing benefit–risk configurations rather than empirically calibrated optimal leverage estimates.
Discussion: ALOM conceptualizes optimal leverage as a condition-dependent and dynamically adjustable financial position rather than a permanently fixed target. The simplified leverage target and adjustment path represent a restricted analytical specification and are not presented as the general closed-form solution to the full stochastic HJB problem. ALOM provides a theoretically testable foundation for subsequent firm-level calibration, empirical validation, and comparison with established capital structure models.

Keywords: Alaali Optimal Leverage Model (ALOM); capital structure; optimal leverage; dynamic leverage; stochastic optimization; default risk; systemic risk; earnings volatility.

1. INTRODUCTION

Capital structure remains one of the central problems in corporate finance because the choice between debt and equity directly affects financing costs, financial flexibility, risk exposure, and ultimately firm value. The modern theoretical debate originates with Modigliani and Miller (1958), who demonstrated that under restrictive assumptions of perfect capital markets, capital structure does not affect firm value. Subsequent research relaxed these assumptions and established that financing decisions become economically relevant when taxation, financial distress, information asymmetry, and other market imperfections are considered (Myers, 1984).

The resulting literature has shown that leverage decisions are influenced by multiple firm-specific characteristics rather than by a single universal determinant. Cross-country evidence identifies factors such as profitability, firm size, asset tangibility, and growth opportunities as important determinants of capital structure, while also demonstrating that their effects may vary across institutional environments (Rajan & Zingales, 1995). Frank and Goyal (2009) further show that a relatively small set of factors—including industry leverage, tangibility, profitability, firm size, and expected inflation—accounts for a substantial portion of observed leverage variation. Nevertheless, despite extensive theoretical and empirical development, capital structure research continues to face unresolved questions concerning how firms determine and adjust their leverage targets under changing conditions (Graham & Leary, 2011).

A central limitation for practical financial decision-making is that leverage cannot always be treated as a stable target. Changes in operating performance, earnings volatility, credit conditions, liquidity, and the broader financial environment can alter both the benefits and risks associated with debt. Consequently, a leverage level that is appropriate under stable conditions may become inefficient or financially dangerous when the firm's risk environment changes. This creates a need for an approach in which optimal leverage responds dynamically to changes in both firm-specific and external conditions.

This study introduces the Alaali Optimal Leverage Model (ALOM) as a dynamic and risk-sensitive approach to capital structure optimization. ALOM conceptualizes optimal leverage as the outcome of a changing balance between the financial benefits of debt and the risks generated by leverage. The model incorporates tax-shield benefits and financing considerations alongside default risk, earnings volatility, liquidity pressure, and systemic risk. In this respect, ALOM extends the broader financial-health modelling logic previously developed through the Alaali Corporate Financial Model (ACFM), while addressing the more specific problem of determining an optimal and dynamically adjustable leverage position (Alaali, 2025).

The objective of this paper is therefore to establish the theoretical foundations of ALOM, formalize its optimization logic, and demonstrate how optimal leverage can change as the financial and risk conditions facing a firm evolve. Rather than proposing a universally fixed debt ratio, ALOM treats leverage as a strategic financial variable whose optimal level is conditional on the firm's prevailing risk-benefit configuration. The paper subsequently develops the model mathematically and illustrates its behaviour under alternative financial and market conditions.

2. LITERATURE REVIEW AND THEORETICAL GAP

Capital structure theory has developed from the benchmark proposition of Modigliani and Miller (1958), which established capital structure irrelevance under restrictive assumptions of perfect capital markets. Once taxes, financial distress, information asymmetry, and other market imperfections are introduced, however, financing structure becomes economically consequential. Myers (1984) framed this problem through the trade-off between the benefits and costs of debt and contrasted it with financing behaviour explained by the pecking order. Fama and French (2002) subsequently provided empirical evidence examining predictions associated with both trade-off and pecking-order explanations.

Capital structure research has also demonstrated that financing decisions are influenced by market conditions and timing. Baker and Wurgler (2002) argue that historical market valuations can have persistent effects on capital structure, while Korajczyk and Levy (2003) show that macroeconomic conditions and financial constraints affect firms' financing choices. These findings challenge the treatment of leverage as a decision determined exclusively by stable firm characteristics and indicate that external financial conditions can materially affect debt-equity decisions.

A further development has been the transition toward dynamic capital structure models. Hennessy and Whited (2005) model debt dynamics under financing frictions, demonstrating that optimal financial policy can evolve with firm conditions. Ju et al. (2005) similarly examine optimal dynamic capital structure and show that leverage decisions must be understood intertemporally rather than as isolated static choices. Flannery and Rangan (2006) provide empirical evidence that firms possess target capital structures but adjust toward those targets gradually, reinforcing the importance of adjustment dynamics.

The literature has also incorporated macroeconomic and risk conditions directly into capital structure modelling. Hackbarth, Miao, and Morellec (2006) demonstrate that macroeconomic conditions influence credit risk and optimal capital structure, providing an important theoretical connection between external economic states and corporate financing decisions. Frank and Goyal (2009), from an empirical perspective, identify several reliable determinants of leverage and demonstrate that capital structure outcomes reflect multiple interacting firm and market characteristics. Graham and Leary (2011) nevertheless conclude that significant unresolved issues remain in explaining observed capital structures and emphasize the need for further development in both theory and empirical modelling.

Dynamic corporate finance research therefore already provides substantial foundations for state-dependent leverage, financing frictions, adjustment behaviour, default exposure, and macroeconomic effects. Strebulaev and Whited (2012) show that dynamic models and structural estimation provide a powerful basis for understanding corporate financial decisions, while also illustrating the complexity involved in translating theoretical optimal policies into empirically observable financing behaviour.

The theoretical gap addressed by ALOM is consequently not the absence of dynamic capital structure models. Rather, it concerns the need for an integrated leverage-optimization structure in which the financial benefits of debt are evaluated jointly against firm-specific risk, earnings volatility, liquidity pressure, default exposure, and systemic or macro-financial risk, with the resulting optimal leverage allowed to change as these conditions evolve. ALOM is positioned as an extension of the existing dynamic capital structure literature that organizes these interacting benefit and risk channels within a unified decision structure designed to produce a condition-dependent optimal leverage target.

3. RATIONALE FOR MODEL DEVELOPMENT

The development of ALOM is motivated by the practical difficulty of determining an appropriate leverage level when the financial environment of a firm is continuously changing. Capital structure decisions occur under conditions in which operating performance, financing constraints, credit quality, market conditions, and macroeconomic risk may change simultaneously. Korajczyk and Levy (2003) demonstrate that macroeconomic conditions interact with financial constraints in shaping capital structure choices, indicating that leverage decisions cannot be separated from the broader environment in which financing occurs.

This problem becomes particularly important when external conditions alter both the benefits and risks of debt. Hackbarth, Miao, and Morellec (2006) show theoretically that macroeconomic conditions affect credit risk and optimal capital structure. A leverage position that is sustainable under favourable economic conditions may therefore become inappropriate when default exposure or macroeconomic risk increases. Similarly, empirical evidence indicates that leverage is associated with multiple firm and market characteristics rather than being determined by a single stable factor (Frank & Goyal, 2009).

ALOM is developed in response to three related requirements. First, leverage optimization should recognize firm-specific volatility because unstable earnings can reduce the firm's capacity to sustain debt. Second, the model should respond to macro-financial and systemic risk because external shocks can change financing conditions and default exposure independently of normal operating performance. Third, the firm's credit and liquidity position should influence the amount of leverage that can be considered optimal rather than merely feasible.

Accordingly, ALOM treats optimal leverage as conditional rather than fixed. The model seeks to determine how much leverage is justified by its financial benefits after accounting for the risk environment confronting the firm. Its purpose is not to reject established capital structure theories, but to translate their central risk-benefit logic into a dynamic optimization structure capable of responding to changing firm-specific and external conditions.

4. THEORETICAL FOUNDATIONS

ALOM is theoretically grounded in the central trade-off principle that debt creates financial benefits but simultaneously increases financial risk. Myers (1984) establishes the broader capital structure problem as a balance involving the benefits and costs associated with financing choices. ALOM retains this fundamental logic but treats the balance as dynamic: the relative value of leverage benefits and leverage risks can change as the firm's financial condition and external risk environment change.

Structural capital structure research provides an important foundation for this approach. Leland (1994) formally connects corporate debt, tax benefits, default risk, and optimal capital structure within a contingent-claims setting. Goldstein, Ju, and Leland (2001) extend this line of reasoning through a dynamic capital structure model in which financing decisions and debt policies evolve over time. These contributions establish that optimal leverage can be derived from the interaction between the benefits generated by debt and the expected costs associated with financial distress and default.

ALOM additionally incorporates the principle that financing decisions occur under uncertainty. Hennessy and Whited (2005) demonstrate that financing frictions and changing firm conditions generate dynamic debt behaviour rather than instantaneous movement toward a fixed capital structure. Hackbarth, Miao, and Morellec (2006) further establish that macroeconomic states influence both credit risk and optimal capital structure. Together, these foundations support the ALOM proposition that leverage should respond not only to internal financial characteristics but also to changes in the external risk environment.

Within ALOM, leverage benefits include the economic value associated with tax shields, potential reductions in financing costs, and financing flexibility. Leverage risks include expected default exposure, earnings volatility, liquidity pressure, and systemic or macro-financial shocks. The optimal leverage position is therefore conceptualized as the point at which the marginal financial benefit generated by additional leverage no longer justifies the marginal increase in risk.

This leverage-specific structure is also consistent with the broader financial-health perspective developed in the Alaali Corporate Financial Model (ACFM), which treats corporate financial condition as a multidimensional phenomenon rather than as the outcome of a single accounting ratio (Alaali, 2025). ALOM narrows that broader perspective to a specific decision problem: determining the leverage position that best balances financing benefits against changing financial and systemic risks. ACFM therefore provides related financial-health context, while ALOM constitutes a distinct leverage-optimization model with its own theoretical and mathematical structure.

The theoretical foundation of ALOM can consequently be summarized through two interacting components: leverage benefits and leverage risks. Optimal leverage is not assumed to be permanently constant. It changes when the underlying benefit-risk configuration changes, providing the conceptual basis for the dynamic mathematical formulation developed in the following section.

5. MODEL DEVELOPMENT

The Alaali Optimal Leverage Model (ALOM) translates the theoretical trade-off between leverage benefits and leverage risks into a dynamic optimization structure. The model builds on structural and dynamic capital structure research showing that optimal financing decisions depend on the interaction between tax benefits, default exposure, firm conditions, financing frictions, and changes in the economic environment (Leland, 1994; Goldstein, Ju, & Leland, 2001; Hennessy & Whited, 2005; Ju et al., 2005; Hackbarth, Miao, & Morellec, 2006).

At its general level, ALOM defines the net attractiveness of leverage as the difference between leverage benefits and leverage risks:

$$\mathbf{ALOM = \Sigma\,(B_i - R_i)}$$

where:

- B_i represents leverage benefits, including tax-shield efficiency, WACC reduction potential, and financing flexibility.
- R_i represents leverage risks, including default probability, earnings volatility, liquidity risk, and systemic risk.

The general formulation represents the economic architecture of ALOM rather than a separate optimization model. Its purpose is to establish the organizing principle from which the dynamic specification is developed: leverage is economically desirable only to the extent that its marginal benefits continue to exceed the financial and systemic risks generated by additional debt. Accordingly, B_i and R_i are not fixed scores. They represent state-dependent economic components whose values may change with the financial condition of the firm and its external environment.

The transition from this general formulation to the mathematical model occurs by expressing the principal benefit and risk channels as components of an intertemporal optimization problem. Tax-shield gains represent the principal leverage benefit in the dynamic specification, while expected distress and default costs represent leverage-related financial risk. Continuous volatility affects the evolution of firm value and therefore default exposure, while discontinuous jump risk represents systemic or macro-financial shocks. Systemic-risk costs are additionally represented through the systemic-risk function, SRF. The general expression $ALOM = \Sigma(B_i - R_i)$ therefore provides the conceptual aggregation rule, while the stochastic specification below provides its dynamic mathematical implementation.

This structure is consistent with structural capital structure models in which debt benefits are evaluated against endogenous default costs (Leland, 1994), as well as dynamic models in which optimal financing policies change through time (Goldstein, Ju, & Leland, 2001; Hennessy & Whited, 2005). The full stochastic specification and the simplified analytical specification developed below serve different purposes. The former represents the general optimization architecture under continuous and discontinuous uncertainty; the latter imposes explicit restrictions to obtain a tractable leverage target and adjustment path. The simplified specification should therefore not be interpreted as an independent model or as the general closed-form solution of the full stochastic problem.

5.1 Application Example

The basic behaviour of ALOM can be illustrated through three hypothetical financial environments. The scenario variables are defined as follows: TSE = Tax-Shield Efficiency; WRP = WACC Reduction Potential; SFF = Strategic Financing Flexibility; DPS = Default Probability Score; EVI = Earnings Volatility Indicator; LSR = Liquidity Stress Risk; and SRF = Systemic Risk Factor.

Scenario	TSE	WRP	SFF	DPS	EVI	LSR	SRF	Illustrative Leverage Target
Stable Growth	0.8	0.7	0.9	0.2	0.3	0.2	0.3	55%
Recession	0.5	0.3	0.6	0.6	0.7	0.6	0.6	40%
Volatile Market	0.6	0.5	0.7	0.4	0.5	0.4	0.5	45%

The scenarios illustrate the directional behaviour of the ALOM benefit–risk mechanism. Under stable-growth conditions, stronger tax-shield efficiency, greater potential for WACC reduction, and greater financing flexibility coexist with relatively low default, volatility, liquidity, and systemic risk. This configuration is therefore associated with a higher illustrative leverage target. During recession, weaker leverage benefits coexist with higher default probability, earnings volatility, liquidity stress, and systemic risk, producing a lower illustrative leverage position. The volatile-market scenario represents an intermediate benefit–risk configuration and therefore an intermediate leverage position.

The parameter values and leverage targets reported in this illustration are hypothetical. They are not outputs estimated, calibrated, or mathematically derived from the stochastic ALOM specification developed below. The percentages should therefore not be interpreted as universal optimal leverage ratios or empirical thresholds. Their sole purpose is to demonstrate the directional logic of the general ALOM architecture. Firm-specific optimal leverage estimates require empirical calibration of the mathematical specification.

5.2 Dynamic Derivation of ALOM

The dynamic specification converts the general ALOM benefit–risk architecture into an intertemporal optimization problem. The connection can be expressed sequentially:

General benefit–risk architecture → stochastic firm-value process → leverage-dependent benefit and risk functions → dynamic optimization → marginal equilibrium condition → restricted no-jump specification → simplified leverage target → partial-adjustment path.

The first step is to specify the evolution of firm value under uncertainty. Following the structural tradition in which financing decisions are connected to uncertain firm value and default risk (Leland, 1994; Goldstein, Ju, & Leland, 2001), ALOM assumes:

$$\mathbf{dV_t = \mu V_t\, dt + \sigma V_t\, dW_t + V_t\, dJ_t}$$

where V_t represents firm value, μ represents expected drift, σ represents continuous volatility, dW_t represents Brownian uncertainty, and dJ_t represents discontinuous changes in firm value.

The jump component is:

$$\mathbf{dJ_t = (Y_t - 1)dN_t}$$

where dN_t represents a Poisson jump process with intensity λ and Y_t represents the proportional magnitude of the jump. The jump component allows ALOM to represent discontinuous macro-financial or systemic shocks rather than assuming that all changes in firm value occur continuously. This is consistent with the broader principle established by Hackbarth, Miao, and Morellec (2006) that macroeconomic conditions can materially alter credit risk and optimal capital structure.

Within this stochastic environment, the general ALOM benefit–risk expression is operationalized by defining the economic value generated by leverage relative to the expected costs associated with leverage-induced financial distress and systemic exposure. A general representation of the firm's optimization objective is:

$$\textbf{Maximize } \mathbf{E[\textstyle\int_0^\infty e^{-rt} \{\tau L_t V_t - \alpha P(Default \mid V_t, L_t)V_t - SRF(L_t, V_t)\}\, dt]}$$

where τ represents the tax-shield coefficient, L_t represents leverage, α represents the economic loss associated with distress or default, $P(\text{Default} \mid V_t, L_t)$ represents leverage-dependent default probability conditional on firm value, and $SRF(L_t, V_t)$ represents the expected systemic-risk cost associated with the leverage position and prevailing financial state.

This objective provides the explicit mathematical bridge to the general ALOM formulation. The term $\tau L_t V_t$ operationalizes a principal component of B_i by representing the economic benefit generated by leverage. The terms $\alpha P(\text{Default} \mid V_t, L_t)V_t$ and $SRF(L_t, V_t)$ operationalize principal components of R_i by representing expected distress/default costs and systemic-risk costs. Volatility and jump intensity affect these risk components through the stochastic evolution of firm value and the probability of entering adverse states. Other benefit and risk components identified in the general formulation, including financing flexibility, WACC effects, and liquidity pressure, can subsequently be incorporated through calibration or additional state-dependent functions without altering the core optimization logic.

Let $F(V)$ denote the optimized value associated with the firm's financing policy, with leverage L treated as the decision variable. The corresponding Hamilton–Jacobi–Bellman condition can be expressed in verbal-formula notation as:

$$\mathbf{r \times F(V) = \textbf{maximum over } L \textbf{ of } \{\tau \times L \times V - \alpha \times P(Default \mid V, L) \times V - SRF(L, V) + \mu \times V \times (\partial F/\partial V) + 0.5 \times \sigma^2 \times V^2 \times (\partial^2 F/\partial V^2) + \lambda \times Expected[F(YV) - F(V)]\}}$$

The HJB expression combines the current benefit of leverage, expected distress/default costs, systemic-risk costs, continuous changes in firm value, and discontinuous jump effects. It therefore represents the full stochastic implementation of the general benefit–risk architecture rather than a mathematically separate model.

Default exposure is represented by the probability that firm value is at or below a leverage-dependent default boundary $\bar{V}(L)$ at horizon t. In the continuous no-jump benchmark, this terminal-horizon probability can be represented as:

$$\mathbf{P(V_t \leq \bar{V}(L)) = \Phi[(\ln(\bar{V}(L)/V_0) - (\mu - 0.5\sigma^2)t) / (\sigma\sqrt{t})]}$$

This expression makes the relationship between leverage and expected distress explicit through $\bar{V}(L)$: a change in leverage changes the relevant default boundary and therefore changes default exposure.

For an interior leverage choice, the marginal benefit of additional leverage must equal the marginal expected cost generated by that leverage. Suppressing other state-dependent terms for clarity, the ALOM marginal equilibrium condition is:

$$\boldsymbol{\tau = \alpha \times \partial P(\text{Default})/\partial L + (1/V) \times \partial SRF/\partial L}$$

The left-hand side represents the marginal leverage benefit. The first term on the right-hand side represents the marginal increase in expected distress/default cost per unit of firm value, while the second represents the marginal increase in systemic-risk cost per unit of firm value. This condition provides the central mathematical connection between the original benefit–risk formulation and the dynamic optimization problem: leverage remains economically desirable until its marginal benefit is offset by its marginal financial and systemic costs.

The full stochastic HJB problem does not generally yield the simplified leverage target used below without additional restrictions. ALOM therefore distinguishes explicitly between the general stochastic specification and a restricted analytical case designed to demonstrate the model's directional behaviour.

For the simplified case, assume that: (1) jump risk is excluded, so $\lambda = 0$; (2) the leverage target is evaluated for a given financial state; (3) systemic-risk costs are temporarily suppressed from the closed-form illustration; (4) the marginal tax benefit is represented by τ; and (5) leverage-related expected distress costs are approximated by a convex reduced-form function that increases with both leverage and volatility.

Specifically, let the simplified net leverage value be:

$$\boldsymbol{G(L) = \tau L - 0.5\alpha\sigma^2 L^2}$$

The first term represents the economic benefit of leverage, with τ representing the constant marginal benefit of leverage under the restricted specification. The second represents a reduced-form expected distress cost that rises convexly with leverage and is amplified by volatility. This restricted expression is not the full stochastic value function. It is an analytical approximation used to derive a transparent benchmark target.

Differentiating G(L) with respect to leverage gives:

$$\boldsymbol{dG/dL = \tau - \alpha\sigma^2 L}$$

At an interior optimum:

$$\boldsymbol{\tau - \alpha\sigma^2 \bar{L} = 0}$$

Therefore:

$$\boldsymbol{\bar{L} = \tau / (\alpha\sigma^2)}$$

The simplified target is thus obtained directly from the restricted benefit–risk specification rather than asserted independently of the general model. It preserves the central directional implications of ALOM: a greater tax benefit increases the target, while greater distress costs or volatility reduce it. Because jump risk and the explicit systemic-risk function have been suppressed, $\bar{L} = \tau/(\alpha\sigma^2)$ is a benchmark target for the restricted no-jump case and not the closed-form solution of the full HJB problem.

To represent adjustment frictions, observed leverage is allowed to converge gradually toward this target:

$$\mathbf{dL_t/dt = \kappa(\bar{L} - L_t)}$$

where $\kappa > 0$ represents the speed of adjustment. With initial leverage L_0, the solution is:

$$\mathbf{L_t = \bar{L}(1 - e^{-kt}) + L_0e^{-kt}}$$

Substituting the simplified target gives:

$$\mathbf{L_t = (\tau / \alpha\sigma^2)(1 - e^{-kt}) + L_0e^{-kt}}$$

When κ is larger, adjustment toward the target occurs more rapidly. As t approaches infinity, the influence of initial leverage diminishes and L_t approaches $\bar{L}$. This adjustment equation describes convergence toward the restricted target; it does not solve the full stochastic HJB problem.

A simple numerical illustration demonstrates the internal operation of the restricted specification. Suppose $\tau = 0.24$, $\alpha = 1.50$, and $\sigma = 0.60$. The simplified target is:

$$\mathbf{\bar{L} = 0.24 / [1.50 \times (0.60)^2] = 0.4444}$$

The corresponding illustrative target leverage is therefore approximately **44.44%**. If initial leverage is 30% and $\kappa = 0.50$, after one period:

$$\mathbf{L_1 = 0.4444(1 - e^{-0.5}) + 0.30e^{-0.5} \approx 0.3568}$$

Observed leverage therefore moves from 30% to approximately **35.68%** after one period rather than immediately reaching 44.44%. If volatility increases from 0.60 to 0.70 while τ and α remain unchanged, the simplified target falls to:

$$\mathbf{\bar{L} = 0.24 / [1.50 \times (0.70)^2] \approx 0.3265}$$

The target therefore declines from approximately **44.44% to 32.65%**, illustrating the model's prediction that greater volatility reduces the amount of leverage that can be economically justified under the restricted specification.

The gradual-adjustment assumption is consistent with empirical evidence that firms do not instantaneously move toward target capital structures because adjustment costs and financing frictions influence the speed of convergence (Flannery & Rangan, 2006). Dynamic financing models similarly support the proposition that observed leverage can deviate persistently from theoretically optimal financing positions (Hennessy & Whited, 2005; Ju et al., 2005).

5.3 Comparative Statics

The mathematical structure of ALOM generates directional relationships at both the general stochastic and restricted analytical levels. These relationships must be distinguished because not every parameter appearing in the full stochastic specification is retained in the simplified target.

Under the restricted target:

$$\bar{L} = \tau / (\alpha\sigma^2)$$

an increase in τ increases optimal leverage because the marginal economic benefit generated by debt becomes larger. An increase in α reduces optimal leverage because the economic consequences of distress become more severe. An increase in σ also reduces optimal leverage because greater volatility amplifies the reduced-form expected distress cost.

The adjustment parameter κ does not determine the target itself. Instead, it determines the speed with which observed leverage converges toward the target. A larger κ produces faster convergence, while a smaller κ implies more persistent deviation between observed and target leverage.

In the full stochastic specification, systemic jump risk enters through λ and the expected jump term. An increase in adverse jump intensity raises exposure to discontinuous negative firm-value states and therefore weakens the economic case for leverage when such shocks increase expected distress or systemic costs. Similarly, an increase in the marginal systemic-risk cost, represented through $\partial SRF/\partial L$, lowers the leverage level consistent with the ALOM marginal equilibrium condition.

The resulting comparative-static predictions are therefore:

- Higher tax-shield benefits → higher optimal leverage.
- Higher expected distress costs → lower optimal leverage.
- Higher continuous volatility → lower optimal leverage.
- Higher adverse systemic jump exposure → lower optimal leverage.
- Higher marginal systemic-risk costs → lower optimal leverage.
- Higher adjustment speed → faster convergence toward the target, but not necessarily a different target.

These relationships connect the general benefit–risk architecture, the stochastic optimization problem, and the restricted analytical target within a single coherent model. They are consistent with structural and dynamic capital structure research while providing the specific condition-dependent benefit–risk architecture through which ALOM organizes leverage optimization (Leland, 1994; Goldstein, Ju, & Leland, 2001; Hackbarth, Miao, & Morellec, 2006).

6. MODEL IMPLICATIONS

ALOM has several implications for both capital structure theory and financial decision-making. Its central implication is that optimal leverage should be interpreted as a condition-dependent financial position rather than as a permanently fixed debt ratio. The appropriate leverage position changes when the underlying balance between leverage benefits and financial or systemic risks changes. This interpretation is consistent with the broader evidence reviewed by Graham and Leary (2011), which shows that observed capital structures cannot be fully explained through simple static relationships and that substantial heterogeneity remains across firms and financing environments.

The model further distinguishes between the determination of a leverage target and the firm's movement toward that target. Within the full stochastic specification, leverage decisions are evaluated under continuous firm-value uncertainty, leverage-dependent default exposure, and discontinuous systemic shocks. The restricted analytical specification serves a different purpose: under explicitly simplifying assumptions, it provides a tractable benchmark target that demonstrates how leverage responds to tax benefits, distress costs, and volatility. The partial-adjustment mechanism then describes how observed leverage can converge gradually toward that target. Accordingly, the simplified target and adjustment path should not be interpreted as the general closed-form solution of the full stochastic HJB problem.

This distinction has an important economic implication. Changes in the determinants of optimal leverage and changes in the speed of leverage adjustment represent separate mechanisms. Higher tax-shield benefits can increase the leverage economically justified by the model, whereas higher volatility, distress costs, systemic jump exposure, or marginal systemic-risk costs can reduce it. By contrast, the adjustment-speed parameter affects how rapidly the firm moves toward its target rather than directly determining the target itself. Financing frictions and adjustment costs can therefore generate persistent differences between observed and theoretically optimal leverage even when the underlying target is identifiable. This distinction is consistent with the dynamic corporate finance literature reviewed by Strebulaev and Whited (2012), in which optimal financial policies depend on state variables and observed corporate decisions may differ substantially from static theoretical predictions.

From a practical perspective, ALOM implies that leverage should be reassessed when material changes occur in the firm's benefit–risk configuration. A leverage position that is economically justified under favourable conditions may cease to be appropriate following an increase in earnings volatility, deterioration in liquidity, higher default exposure, greater distress costs, or an increase in systemic risk. Conversely, improvements in financial resilience, reductions in volatility or systemic exposure, or stronger economic benefits from debt may increase the amount of leverage that can be justified.

The model also provides a basis for distinguishing normal financial uncertainty from discontinuous systemic exposure. Continuous volatility affects the evolution of firm value and expected distress, whereas the jump component of the full stochastic specification represents abrupt macro-financial or systemic shocks. This distinction is potentially important for firms whose leverage capacity is highly sensitive to economic regimes, commodity-price shocks, credit-market disruptions, or other discontinuous changes in the external environment.

The numerical illustration of the restricted specification further demonstrates that ALOM generates testable directional implications rather than merely describing a conceptual relationship. Under the simplified target, greater volatility or distress costs reduce the leverage target, while greater tax benefits increase it. The partial-adjustment mechanism separately predicts that firms subject to stronger adjustment frictions will remain away from their target for longer periods. These relationships provide observable implications that can subsequently be examined using firm-level data.

ALOM therefore provides a theoretical basis for dynamic leverage recalibration, forward-looking credit assessment, and scenario-based financing analysis. Its potential relevance is particularly strong for cyclical and capital-intensive firms whose debt capacity and risk exposure can change materially across economic and market conditions. However, practical use of ALOM for firm-specific leverage recommendations requires empirical estimation and calibration of its parameters.

The theoretical model establishes the decision architecture and directional predictions; it does not establish universal leverage thresholds.

7. CONCLUSION AND FUTURE RESEARCH

This paper develops the Alaali Optimal Leverage Model (ALOM) as a dynamic and risk-sensitive approach to capital structure optimization. The model is based on the principle that optimal leverage emerges from the changing balance between the financial benefits generated by debt and the financial and systemic risks created by additional leverage. Rather than assuming a permanently fixed target, ALOM treats optimal leverage as a condition-dependent financial position that can change as firm-specific and external conditions evolve.

The model develops this principle through connected levels of formalization. The general formulation, $\mathbf{ALOM = \Sigma(B_i - R_i)}$, establishes the underlying benefit–risk architecture. The stochastic specification translates that architecture into a dynamic optimization problem in which firm value evolves under continuous uncertainty and discontinuous jump risk, while leverage generates economic benefits alongside expected distress/default and systemic-risk costs. The resulting marginal equilibrium condition expresses the central ALOM principle that additional leverage remains economically justified until its marginal benefit is offset by its marginal financial and systemic costs.

A restricted analytical specification then provides a tractable representation of this logic under explicit simplifying assumptions. By excluding jump risk and temporarily suppressing the explicit systemic-risk component, the restricted specification produces the benchmark target $\mathbf{\bar{L} = \tau/(\alpha\sigma^2)}$. This target demonstrates directly how greater tax benefits increase leverage while greater volatility and distress costs reduce it. The partial-adjustment equation subsequently describes gradual convergence toward this target when adjustment frictions prevent instantaneous leverage changes. The restricted target and adjustment path are therefore analytical components of ALOM under simplifying assumptions and should not be interpreted as the general closed-form solution of the full stochastic HJB problem.

The principal contribution of ALOM is not the claim that dynamic leverage, default risk, adjustment frictions, or macroeconomic conditions have been absent from previous capital structure research. Its contribution lies in organizing leverage benefits, firm-specific financial risks, continuous uncertainty, discontinuous systemic shocks, and dynamic adjustment within an integrated benefit–risk optimization architecture designed to determine and explain a condition-dependent leverage position.

The present study establishes the theoretical and mathematical foundations of ALOM rather than providing definitive empirical validation. The numerical and scenario illustrations demonstrate the internal and directional behaviour of the model but do not constitute empirical estimates of optimal leverage. Firm-specific implementation therefore requires calibration of the relevant parameters and risk functions.

Future research should estimate and calibrate ALOM using firm-level financial data and test its principal comparative-static predictions. In particular, empirical analysis can examine whether increases in earnings volatility, distress exposure, and systemic risk are associated with reductions in estimated optimal leverage; whether stronger debt benefits increase the target; and whether observed leverage converges toward estimated targets at speeds consistent with the partial-adjustment mechanism. Subsequent research should also estimate the systemic-risk function and jump parameters, examine alternative specifications of the leverage-dependent default boundary, and determine whether incorporating discontinuous systemic risk materially improves leverage estimation.

Further validation should examine ALOM across sectors, economic regimes, and institutional environments, particularly in cyclical and capital-intensive industries where leverage capacity may change substantially with external conditions. Comparative testing against established static and dynamic capital structure models would provide the strongest evidence regarding whether ALOM offers incremental explanatory, predictive, or decision-relevant value.

Accordingly, ALOM should be regarded as a theoretically derived and empirically testable financial model rather than a source of universal leverage thresholds. Its ultimate value depends on calibration, empirical validation, and comparative performance. The integrated derivation developed in this study provides the foundation for that next stage of research.

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Appendix A - Note 1: DFAS-EEP Compliance Note: This manuscript is formally safeguarded under the **DFAS-EEP (Editor Ethics Protocol)**. All stages of submission, review, and editorial handling are subject to **traceability, transparency, and ethical accountability** (Alaali, 2025b).

- **Procedural Violations:** Any departure from declared editorial or peer review standards will be logged.
- **Peer Review Misconduct:** Evidence of bias, conflict of interest, or failure to follow fair-review practices will be recorded.
- **Editorial Anomalies:** Irregularities such as unexplained desk rejections, missing reviewer reports, or non-transparent decisions will be archived.

All such cases are documented in the **DFAS - Ethical Integrity Reporting (DFAS-EIR) Archive**, serving as an immutable record for oversight, research integrity, and enforcement of ethical compliance across the publishing process.
For more information, refer to SSRN:
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5375339

Appendix A – Note 2: DFAS-FEP Authorship Classification and Compliance:
This manuscript complies with the **DFAS-FEP Protocol,** a structured authorship governance framework introduced by the author (Alaali, 2025a).
DFAS-FEP (Dynamic Financial Applied Meta-Science – Future Engine Prototype Protocol) provides an ethical protocol to ensure transparent and accountable authorship in AI-assisted financial research. It defines and enforces the distinction between fully human-generated content and AI-supported elements to uphold integrity, intellectual responsibility, and traceability across all components of this manuscript.
This classification directly supports the ethical architecture of the **DFAS-IFRS Code of Ethics**, which applies DFAS-FEP standards to financial disclosures influenced by artificial intelligence.
For reference, see the published DFAS-FEP Protocol:
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5260517

Appendix A.1 – (DFAS-FEP) Authorship Classification Table for This Manuscript

Manuscript Component	DFAS–FEP Class	Justification
Alaali Optimal Leverage Model (ALOM)	**Class 1**	The **ALOM** and its conceptualization of optimal leverage as a condition-dependent and dynamically adjustable financial position were fully conceptualized and developed by the author.

Integrated Leverage Benefit–Risk Architecture	**Class 1**	The integration of leverage benefits and risks within a unified optimization architecture was independently developed by the author. Benefits include **tax-shield efficiency, WACC reduction potential, and financing flexibility**, while risks include **default probability, earnings volatility, liquidity risk, and systemic risk**.
General ALOM Formulation	**Class 1**	The formulation **ALOM = $\Sigma(B_i - R_i)$** was developed by the author to express the changing net attractiveness of leverage as the difference between its financial benefits and associated risks and to provide the conceptual aggregation rule underlying the subsequent dynamic specification.
General-to-Dynamic Formalization Architecture	**Class 1**	The sequential architecture connecting the general benefit–risk formulation to the stochastic firm-value process, dynamic optimization problem, marginal equilibrium condition, restricted analytical specification, simplified leverage target, and partial-adjustment path was structured by the author to provide a coherent mathematical progression within ALOM.
Condition-Dependent Optimal Leverage Principle	**Class 1**	The principle that optimal leverage changes when the underlying financial benefit–risk configuration changes, rather than representing a permanently fixed debt ratio, was independently structured by the author.
Stochastic Firm-Value Architecture	**Class 1**	The ALOM stochastic specification integrating expected drift, continuous volatility, Brownian uncertainty, and discontinuous jump risk was structured by the author as the dynamic foundation for leverage optimization.
Systemic Jump-Risk Mechanism	**Class 1**	The incorporation of a **Poisson jump process** into ALOM was developed to represent discontinuous macro-financial and systemic shocks affecting firm value and leverage decisions.
Dynamic Leverage Optimization Objective	**Class 1**	The optimization architecture balancing leverage-generated economic benefits against leverage-dependent expected distress/default costs and systemic-risk costs under changing financial states was independently developed for ALOM.
Systemic-Risk Function (SRF)	**Class 1**	The **SRF(L, V)** component was structured within ALOM to represent expected systemic-risk costs associated with leverage and the prevailing financial state and to connect systemic exposure directly to the model's optimization and marginal equilibrium conditions.
Hamilton–Jacobi–Bellman (HJB) Optimization Structure	**Class 1**	The application and specification of the **HJB optimization structure** within ALOM were developed to determine leverage under continuous firm-value uncertainty, leverage-dependent distress exposure, and discontinuous systemic shocks.
Leverage-Dependent Default Boundary and Probability Architecture	**Class 1**	The integration of a leverage-dependent default boundary and corresponding default-probability mechanism was structured by the author to connect changes in leverage with endogenous financial distress exposure.
ALOM Marginal	**Class 1**	The equilibrium condition **$\tau = \alpha \times \partial P(\text{Default})/\partial L + (1/V) \times \partial SRF/\partial L$** was structured to represent the point at which the marginal economic benefit of additional leverage is

Equilibrium Condition		offset by marginal expected default and systemic-risk costs.
Restricted Analytical Specification	**Class 1**	The restricted analytical specification was developed by the author to connect the general stochastic ALOM architecture to a tractable benchmark under explicit simplifying assumptions, including exclusion of jump risk, suppression of the explicit systemic-risk component, and a reduced-form representation of leverage-related distress costs.
Reduced-Form Net Leverage Function	**Class 1**	The restricted function $\mathbf{G(L) = \tau L - 0.5\alpha\sigma^2 L^2}$ was structured to represent leverage benefits against convex volatility-sensitive distress costs and to provide an explicit derivational basis for the simplified leverage target.
Simplified Optimal Leverage Target	**Class 1**	The simplified no-jump target $\mathbf{\bar{L} = \tau/(\alpha\sigma^2)}$ was derived from the restricted analytical specification to demonstrate the directional relationship among tax benefits, distress costs, volatility, and optimal leverage. It is treated as a benchmark target rather than as the general closed-form solution to the full stochastic HJB problem.
Dynamic Partial-Adjustment Mechanism	**Class 1**	The adjustment equation $\mathbf{dL_t/dt = \kappa(\bar{L} - L_t)}$ and resulting convergence path were incorporated to model gradual rather than instantaneous movement toward the restricted leverage target when adjustment frictions are present.
Numerical Illustration Architecture	**Class 1**	The numerical illustration was constructed to demonstrate the internal operation of the restricted ALOM specification, including calculation of the simplified leverage target, gradual convergence from initial leverage, and the directional effect of changing volatility.
ALOM Comparative-Statics Architecture	**Class 1**	The directional relationships linking optimal leverage to **tax benefits, earnings volatility, systemic jump exposure, distress costs, systemic-risk costs, and adjustment speed** were independently structured by the author, with explicit distinction between determinants of the leverage target and determinants of adjustment speed.
Illustrative Financial Scenario Architecture	**Class 1**	The **Stable Growth, Recession, and Volatile Market** scenarios were constructed to demonstrate how alternative benefit–risk configurations generate different illustrative leverage positions.
Scenario Indicator Architecture	**Class 1**	The scenario structure incorporating **Tax-Shield Efficiency (TSE), WACC Reduction Potential (WRP), Strategic Financing Flexibility (SFF), Default Probability Score (DPS), Earnings Volatility Indicator (EVI), Liquidity Stress Risk (LSR), and Systemic Risk Factor (SRF)** was developed to represent alternative leverage benefit–risk configurations.
Dynamic Leverage Recalibration Logic	**Class 1**	The principle that firms should reassess leverage following material changes in earnings volatility, liquidity, default exposure, financing benefits, distress costs, or systemic risk was developed as an operational implication of ALOM.
Narrative Structure and Analytical Exposition	**Class 2**	AI assistance was limited to controlled linguistic refinement, clarity, and structural presentation.

Tables, Equations, and Model Presentation	**Class 2**	The substantive model architecture, equations, parameters, assumptions, and relationships were author-developed; AI assistance was restricted to formatting and presentation refinement.
Literature Review and Cross-Referencing	**Class 2**	Literature interpretation and theoretical positioning were author-directed; AI assistance was limited to citation and reference alignment.
Appendices and Compliance Documentation	**Class 2**	AI assistance was restricted to formatting and structural consistency.

Overall Manuscript Classification: Class 2 – AI-Assisted, Author-Validated

Core ALOM Model, Benefit–Risk Architecture, Mathematical Derivation, Dynamic Optimization, Risk Mechanisms, Restricted Analytical Specification, and Adjustment Logic: Class 1 – Fully Human-Authored

Additional Clarifications

Human-Originated Content (Class 1): All substantive contributions including **ALOM; the integrated benefit–risk architecture; ALOM = $\Sigma(B_i - R_i)$;** the general-to-dynamic formalization architecture; condition-dependent optimal leverage principle; stochastic firm-value architecture; systemic jump-risk mechanism; dynamic optimization objective; systemic-risk function; HJB structure; leverage-dependent default architecture; marginal equilibrium condition; restricted analytical specification; reduced-form net leverage function; simplified leverage target; partial-adjustment mechanism; numerical illustration architecture; comparative-statics architecture; scenario architecture; scenario indicator architecture; and dynamic leverage recalibration logic were independently conceptualized and developed by the author.

AI-Assisted Content (Class 2): AI tools were used only for non-substantive linguistic refinement, formatting, structural presentation, and citation alignment.

Integrity Safeguards: All AI-assisted content was manually reviewed and validated under **DFAS-FEP v1.6**, with authorship classification and traceability documentation maintained.

Appendix B – Version History Log (VHL)

Version 1.0 – First Published on SSRN on March 20, 2025; Revised on June 2, 2025.
• https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5179472

• The manuscript introduced the theoretical foundations of the **Alaali Optimal Leverage Model (ALOM)** as a dynamic, multi-factor, and risk-sensitive approach to capital structure optimization, including its benefit–risk formulation, stochastic derivation, systemic jump-risk mechanism, default-risk function, equilibrium condition, dynamic leverage adjustment, comparative statics, and scenario-based application.
• **Alaali-ACS: 0 | Classification: Class II – AI-Assisted, Author-Validated**

Version 2.0 – Revised August 26, 2026.
• The manuscript was substantially revised to strengthen the theoretical positioning and mathematical presentation of **ALOM**, clarify that its contribution is an integrated and condition-dependent **benefit–risk leverage optimization structure** rather than a claim that dynamic capital

structure modelling itself is novel, distinguish the illustrative scenario targets from mathematically derived optimal leverage estimates, clarify the relationship between the full stochastic HJB specification and the simplified no-jump partial-adjustment solution, and strengthen the model's comparative statics, limitations, empirical testability, and future validation pathway.

• **Alaali-ACS: 0 | Classification: Class II – AI-Assisted, Author-Validated**

Version 3.0 – Major Revision in Response to Journal Review, September 4, 2026.

• The manuscript was substantially revised in response to the journal's **Major Revision** decision. The revision establishes an explicit mathematical progression from the general **ALOM** $= \Sigma(B_i - R_i)$ benefit–risk formulation to the stochastic firm-value process, dynamic HJB optimization, leverage-dependent default mechanism, systemic-risk function, and marginal equilibrium condition. It further introduces explicit simplifying assumptions and a reduced-form net leverage function to derive the restricted no-jump target $\bar{L} = \tau/(\alpha\sigma^2)$, clearly distinguishing this benchmark from the full stochastic HJB problem. A worked numerical illustration was added, all scenario variables were defined, the systemic-risk component was clarified, and the comparative statics, model implications, conclusions, and authorship-classification documentation were revised for consistency with the strengthened derivation.

• **Alaali-ACS: 0 | Classification: Class II – AI-Assisted, Author-Validated**