European Journal of Sustainable Development Research
2027, 11(1), em0448
e-ISSN: 2542-4742
https://www.ejosdr.com/

MODESTUM

Research Article **OPEN ACCESS**

Corporate financial sustainability at risk: Growth volatility, diversification strategies, and bankruptcy risk

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Citation: Vu, T. H., & Ngo, T. T. (2027). Corporate financial sustainability at risk: Growth volatility, diversification strategies, and bankruptcy risk. *European Journal of Sustainable Development Research, 11*(1), em0448. https://doi.org/10.29333/ejosdr/20003

ARTICLE INFO

Received: 07 Mar. 2026
Accepted: 29 Aug. 2026

ABSTRACT

Corporate financial sustainability is essential for sustainable economic development, yet limited research examines how firm-level growth instability and strategic responses affect bankruptcy risk in emerging markets. This study investigates the relationships between growth volatility, business diversification strategies, and bankruptcy risk using panel data on 485 non-financial Vietnamese listed firms (5,325 firm-year observations) from 2013–2024. Applying partial least squares structural equation modeling (PLS-SEM), growth volatility is modeled as a multidimensional formative construct. The findings reveal that current growth volatility is directly associated with higher bankruptcy risk and with a greater tendency toward related diversification, which is in turn associated with amplified vulnerability through a significant mediating pathway. Unrelated diversification is associated with lower bankruptcy risk, but current volatility is not significantly associated with firms pursuing it. Lagged volatility is associated with diversification choices without being directly associated with current bankruptcy risk. These results highlight diversification composition as a key correlate of corporate financial sustainability in emerging economies, with implications for SDG 8 and SDG 9 attainment.

Keywords: corporate sustainability, growth volatility, business diversification, bankruptcy risk, sustainable development, PLS-SEM

INTRODUCTION

Sustainable development depends not only on macroeconomic stability but also on the financial resilience of the firms that constitute the productive base of the economy. The United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure), explicitly recognize that sustained, inclusive growth requires resilient business enterprises (Sethi & Mahadik, 2025). When firms fall into severe financial distress or bankruptcy, the consequences extend beyond shareholders to employees, suppliers, local communities, and broader value chains (Antoniades et al., 2020; Boubaker et al., 2020). Zambrano Farias et al. (2021) argue that business failure directly undermines the attainment of multiple SDGs because decent work and economic growth are only possible if companies survive. This concern is especially acute in emerging markets such as Vietnam, where the corporate sector plays a central role in employment and growth while capital markets and restructuring institutions remain relatively less developed. In such settings, corporate bankruptcy is not merely a firm-level financial outcome but a challenge to sustainable development itself. At the firm level, this study adopts the working definition of corporate financial sustainability as a firm's capacity to maintain solvency, meet financial obligations, and sustain operations over the long term while adapting to volatility in operating conditions, thereby preserving the productive base needed for inclusive economic development. This definition extends the firm-level operationalisation found in the corporate-finance literature into an explicit alignment with the SDG framework: corporate financial sustainability supports SDG 8 (decent work and economic growth) by safeguarding employment continuity, SDG 9 (industry, innovation, and infrastructure) by maintaining the productive capacity of listed firms that anchor industrial development, and SDG 12 (responsible production) by allowing firms to adopt longer planning horizons that incorporate sustainability considerations rather than survive crisis-mode short-term decisions. Episodes of corporate distress in emerging economies — including Vietnam during the COVID-19 disruption of 2020–2021 — have demonstrated that without firm-level financial resilience, broader sustainable development outcomes are themselves placed at risk.

Growth volatility is an important source of that vulnerability. Fluctuations in sales, assets, employment, and operating profits capture instability in firms' growth processes

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and may signal deteriorating operating conditions, tighter financing constraints, and rising default risk (Barrero et al., 2017; Comin & Philippon, 2005; Rashid et al., 2021). A large body of macroeconomic research confirms that volatility undermines sustainable economic growth: Ramey and Ramey (1995) document a robust negative relationship between output volatility and growth across 92 countries, a finding that is particularly severe in developing economies with weaker institutions. At the firm level, volatility functions as a risk signal. As posited by signaling theory (Ross, 1977; Spence, 1973), growth volatility is closely associated with the risk–return perceptions of investors and creditors. Elevated volatility may prompt adverse stakeholder reactions, with investors adjusting portfolios and creditors tightening lending terms, thereby depressing market value and increasing bankruptcy risk when market value approaches or falls below debt levels (Malkiel, 2003; Merton, 1974). Conversely, firms with stable growth attract investors by signaling operational confidence (Badrinath et al., 1989). Recent evidence from Vietnam also shows that firm-level volatility is closely associated with financial distress (Vuong et al., 2024). Yet growth volatility is unlikely to affect bankruptcy risk solely through a direct channel. It may also shape how managers respond strategically under uncertainty, particularly through business diversification decisions. Moreover, because different stakeholder groups process information at different speeds, both current and past volatility may influence outcomes, a temporal dimension that has received limited attention. The temporal distinction between current and lagged growth volatility — central to our research design — is grounded in two complementary behavioural arguments. Current volatility operates as an immediate risk signal that managers and investors process under bounded rationality and recency bias: salient and cognitively available, it triggers near-term strategic responses (Hambrick & Mason, 1984). Lagged volatility, by contrast, operates as accumulated information that managers integrate into resource accumulation, capability development, and slower-moving structural decisions (the Penrose effect). Modelling these two horizons separately therefore allows the structural model to capture both the contemporaneous response to a salient signal and the more gradual learning-and-adjustment response, which empirical evidence suggests are driven by different mechanisms (Coad et al., 2017).

Diversification is one of the most important strategic responses available to firms facing instability (Ansoff, 1957; Knecht, 2013), but its financial consequences are not uniform. When volatility increases, firms may gravitate toward related diversification to leverage existing synergies and stabilize operations, consistent with the theory of economies of scope (Markides & Williamson, 1994; Rumelt, 1982). Conversely, when volatility subsides and uncertainty diminishes, firms may pursue unrelated diversification across less correlated industries, consistent with portfolio theory (Markowitz, 1952). Crucially, these two pathways have asymmetric implications for bankruptcy risk: related diversification may expose firms to correlated downturns, whereas unrelated diversification offers broader risk-spreading benefits (Bettis & Hall, 1982; Singhal & Zhu, 2013; Thanh et al., 2021). Recent research confirms that these asymmetric effects are empirically relevant in emerging markets (Vu & Ngo, 2025). However, prior research has not sufficiently integrated these relationships into a single framework that explains how growth volatility influences related and unrelated diversification, and how those strategies, in turn, shape bankruptcy risk. This gap is particularly important because corporate financial distress produces negative externalities such as unemployment, supply chain disruption, and community welfare loss that undermine the broader sustainability agenda (Boubaker et al., 2020; Song & Zhao, 2024). Moreover, institutional frictions in emerging markets can magnify the consequences of both volatility and strategic misalignment (Asis et al., 2021; Zouaghi et al., 2024).

This study addresses that gap by integrating signaling theory, Upper Echelons Theory, portfolio theory, and the theory of economies of scope to examine how growth volatility operates as a risk signal, how managers respond through diversification choices, and why related and unrelated diversification may have asymmetric effects on bankruptcy risk. The conceptual model and associated hypotheses are developed in the following section. More specifically, the present study fills three interrelated gaps in the existing literature. First, prior studies typically examine the direct effect of growth volatility on bankruptcy risk without examining the strategic mediation through diversification choices, leaving unexplored the channel through which volatility is transmitted into financial distress. Second, the literature has tended to treat diversification as a uniform construct or to focus on its overall level, without systematically distinguishing related from unrelated forms in their effects on bankruptcy risk; we model these as parallel mediators and document an asymmetric pattern that has substantive theoretical and practical implications. Third, the diversification–distress evidence base in frontier-market contexts such as Vietnam — characterised by concentrated ownership, thin managerial labour markets, and ongoing institutional reform — remains thin, leaving open the question of whether mechanisms documented in developed or large emerging markets generalise to such settings. By addressing these gaps within a single integrated framework, the present study contributes both to the corporate-finance literature on bankruptcy risk and to the broader sustainable-development agenda concerned with firm-level resilience in emerging economies.

Vietnam offers a particularly compelling setting for this investigation. As a rapidly developing emerging economy with a young stock market and limited institutional infrastructure for corporate restructuring, Vietnam exemplifies the conditions under which growth volatility can pose acute threats to corporate financial sustainability (Le et al., 2024; Vuong et al., 2024). The country's ongoing integration into global value chains, combined with periodic macroeconomic shocks, exposes firms to significant growth instability. In such an environment, corporate failure carries disproportionate consequences for sustainable development: the World Bank (2022) documents that corporate debt overhang in emerging and developing economies constrains growth and financial sector stability, with cascading effects on employment and public investment. Understanding how diversification can serve as a resilience mechanism in this context is both timely and practically relevant for achieving the SDGs.

Using panel data from 485 non-financial Vietnamese listed firms (5,325 firm-year observations) over 2013–2024, the study applies partial least squares structural equation modeling (PLS-SEM) to examine the direct effects of growth volatility on bankruptcy risk, the effects of current and lagged volatility on related and unrelated diversification, and the indirect effects of diversification strategies on the volatility–bankruptcy relationship. Growth volatility is modeled as a formative latent construct comprising four dimensions: employment, assets, sales, and operating profits. Robustness checks, including an alternative accounting-based bankruptcy proxy (Altman Z-score), endogeneity tests (Gaussian copula), unobserved heterogeneity (FIMIX-PLS), and nonlinear effect assessments, ensure the reliability of the findings.

Methodologically, the study employs PLS-SEM not as a substitute for panel-econometric estimators (such as fixed-effects or GMM) but as the appropriate estimator for a system that combines a formative composite construct of growth volatility, four parallel mediators (related and unrelated diversification at current and lagged horizons), and three endogenous outcome variables. The detailed motivation and bounded scope of this methodological choice — including how the panel structure is preserved through demeaning and how endogeneity, unobserved heterogeneity, and non-linearity are addressed — are set out in Section *Structural equation modelling* and Section *Robustness Check*.

This research contributes to the literature on corporate financial sustainability in three ways. First, it provides empirical evidence that growth volatility is associated with reduced corporate financial sustainability both directly and indirectly through a risk-amplifying diversification pathway, thereby indicating how firm-level instability may undermine the conditions necessary for SDG 8 and SDG 9 attainment. Second, by distinguishing between current and lagged growth volatility, the study captures both contemporaneous and delayed effects, indicating that the timing of instability is associated with both diversification choices and bankruptcy outcomes. Third, it models growth volatility as a multidimensional formative construct, encompassing employment, asset, sales, and operating-profit volatility, rather than relying on a single dimension, advancing methodological practice in sustainability-oriented corporate finance research within an underexplored emerging-market context. By integrating signaling theory, Upper Echelons Theory, the theory of economies of scope, and portfolio theory into a unified analytical chain — signaling theory as the trigger, Upper Echelons Theory and the theory of economies of scope jointly governing the choice mechanism, and portfolio theory as the outcome filter — the study clarifies not only that growth volatility is associated with reduced corporate financial sustainability but how strategic mediation through diversification is associated with asymmetric bankruptcy-risk outcomes, a prediction that no single theory can generate alone.

LITERATURE REVIEW

Bankruptcy Risk

Bankruptcy risk, the probability that a firm will be unable to meet its financial obligations, poses severe challenges for stakeholders and causes substantial economic losses (Bărbuță-Mișu & Madaleno, 2020; Wu, 2010). From a sustainable development perspective, corporate failures extend beyond financial markets, destroying employment, disrupting supply chains, and undermining community welfare (Boubaker et al., 2020; Sethi & Mahadik, 2025). Two primary approaches to measuring bankruptcy risk exist: composite accounting-based measures such as Altman's (1968) Z-score or Ohlson's (1980) O-score, and market-based measures such as the KMV-Merton model (Hillegeist et al., 2004; Li & Faff, 2019). This study employs the KMV-Merton model, as detailed in the Methods section.

Bankruptcy risk is influenced by financial indicators (leverage, liquidity, profitability), market-based indicators (stock return volatility, market-to-book ratios), corporate governance (Darrat et al., 2016), and macroeconomic conditions (Campbell et al., 2008; Everett & Watson, 1998). Firm-level volatility is a particularly critical determinant: high volatility increases uncertainty about financial stability, leading to liquidity constraints, higher risk premiums, and stricter lending terms (Campbell et al., 2008; Merton, 1974). This study focuses specifically on growth volatility - encompassing employment, asset, sales, and operating profit growth - as a multidimensional predictor of bankruptcy risk.

Understanding and mitigating bankruptcy risk is therefore essential not only for firm survival but also for sustainable development. Because corporate failures produce cascading negative externalities such as unemployment, supply chain disruption, and reduced community welfare, they directly undermine the conditions necessary for achieving SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure) (Song & Zhao, 2024; Zambrano Farias et al., 2021). This study accordingly frames bankruptcy risk not only as a firm-level financial outcome but also as a challenge to corporate financial sustainability within the broader development agenda.

Firm Growth Volatility and Bankruptcy Risk

Firm growth volatility

Firm-level volatility indicates the instability of a firm (Barrero et al., 2017) and encompasses multiple dimensions including sales, earnings, employment, and asset volatility (De Veirman & Levin, 2012). Prior studies have typically examined single dimensions; earnings volatility (Abdel-Khalik, 2007), sales growth volatility (Comin & Mulani, 2009; Rashid et al., 2021), or cash flow volatility (Chi & Su, 2017); without capturing the multidimensional nature of growth instability.

Building on the firm growth literature, Coad et al. (2017) identified four key dimensions of firm growth: assets, employment, sales, and operating profits, extending the work of Penrose (1959), Coad and Guenther (2014), and Daunfeldt et al. (2014). This multidimensional approach recognizes that no

single growth indicator is universally superior (Davidsson & Wiklund, 2017; Delmar et al., 2003).

Since firm growth level is specified by four types recommended by Coad et al. (2017), firm growth volatility in this study is conceptualized using four corresponding types of volatility: assets, employment, sales, and operating profit volatility.

Firm growth volatility and bankruptcy risk

The interplay between growth volatility and financial distress is well-documented. Growth volatility is expressed in various dimensions such as revenue, labour, assets, and income (De Veirman & Levin, 2012), and as volatility increases, a firm's bankruptcy risk also rises (Rashid et al., 2021). From the signaling theory perspective (Spence, 1973), increased growth volatility signals heightened financial difficulties, which in turn exacerbate bankruptcy risk (Elkamhi et al., 2012). The research by Baptista et al. (2020) and Rashid et al. (2021) reinforces the notion that growth volatility is a critical indicator of corporate instability, underscoring the necessity for firms to monitor and manage growth volatility to mitigate potential financial crises.

Furthermore, growth volatility acts as a risk signal to capital market participants. Signaling theory suggests that increased volatility conveys information about a firm's underlying instability, guiding investor and creditor behavior (Spence, 1973; Ross, 1977). Investors who perceive higher risk may reduce their holdings or avoid future purchases, while creditors may tighten lending terms or raise borrowing costs (Malkiel, 2003; Campbell et al., 2008). These reactions can depress stock prices, decreasing the firm's market value and increasing bankruptcy risk when the market value approaches or falls below debt levels (Merton, 1974). Conversely, firms with low growth volatility attract investors by signaling stability and operational confidence (Badrinath et al., 1989). It should be noted that not all market participants react simultaneously: some investors respond immediately to new information, while others, such as long-term institutional investors, may react more gradually, expecting the firm to adjust. This implies that both current and past volatility can influence investor behavior and, by extension, bankruptcy risk.

Based on signaling theory and the structural credit risk framework (Merton, 1974), the research hypotheses are formulated as follows:

H1: Volatility in growth will increase bankruptcy risk.

H2: Past volatility in growth will exacerbate bankruptcy risk.

In addition to investor reactions, firms also react to their own operational volatility. Rashid et al. (2021) argue that in order to achieve sustainable long-run growth, firms are required to stabilize their operations, output demands, and earnings through both financial derivatives such as currency and interest-rate derivatives and non-derivative hedging strategies such as product diversification and internationalization. Thesmar and Thoenig (2011) provide evidence that, at the firm level, sales and employment volatility are impacted by changes in the degree of ownership concentration. Garcia-Vega et al. (2012) find that exports tend to stabilize firms' sales through market diversification. In summary, firms can manage their volatility by various means, including diversification.

Business Diversification

Business diversification, a firm's expansion into multiple product markets or industries, has been extensively studied as a corporate strategy (Knecht, 2013). Following the foundational classification of Rumelt (1974), which remains the most widely used framework (Datta et al., 1991; Mayer & Whittington, 2003), this study focuses on two primary types: related diversification (expansion into industries sharing resources, technologies, or markets with the core business) and unrelated diversification (expansion into industries with no operational linkages to the core business). This classification, supported by Knecht (2013), enables the examination of asymmetric effects on bankruptcy risk.

Diversification: The reaction to growth volatility

The reasons firms decide to diversify are well-documented. A firm's decision to diversify may be driven by a number of different reasons and is influenced by a variety of factors (Knecht, 2013). Montgomery (1994) identifies three main theoretical perspectives that explain from a strategic management standpoint a firm's choice to diversify, namely, (i) the resource-based view, (ii) the agency theory, and (iii) the market power argument. Galunic and Eisenhardt (2001) identify dynamic capabilities as a motive for diversification. Knecht (2013) adds transaction costs and risk reduction to the list.

From a risk management perspective, growth volatility serves as a critical warning signal. Signaling theory emphasizes how observable indicators communicate underlying conditions to stakeholders (Barrero et al., 2017). High growth volatility signals macroeconomic challenges or competitive pressures, forecasting future instability (Comin & Philippon, 2005; Rashid et al., 2021), whereas low volatility reflects stability and favorable conditions (Comin & Philippon, 2005). Importantly, volatility signals not only to investors and creditors but also to managers, who must decide how to respond strategically.

A more fitting lens for analysing how managerial perceptions of growth volatility translate into corporate diversification choices is Upper Echelons Theory (Hambrick & Mason, 1984). Upper Echelons Theory holds that organisational outcomes — strategies and effectiveness — are partial reflections of the values and cognitive bases of powerful actors in the organisation. Under this lens, growth volatility serves as an environmental cue that top managers perceive, interpret, and act upon through their cognitive and experiential filters. Two implications follow for the diversification decision. First, when faced with rising growth volatility, managers are more likely to choose strategic responses that are cognitively and operationally available — namely, related diversification, which leverages familiar resources, capabilities, and routines — rather than unrelated diversification, which requires the acquisition of new capabilities and longer planning horizons. Second, in institutional environments characterised by concentrated ownership, thin managerial labour markets, and limited

external monitoring (such as the Vietnamese setting), the cognitive and behavioural filters of top management play an even larger role in shaping diversification choices, because external discipline that would otherwise constrain managerial cognitive bias is weaker (Khanna & Palepu, 2000). Upper Echelons Theory therefore provides the behavioural micro-foundation for the choice mechanism in our integrated framework: managers respond to volatility signals through the diversification mode that is most accessible given their cognitive profile and resource base, even when this mode is not the one most likely to reduce bankruptcy risk.

Among available strategic responses, diversification emerges as a widely recognized approach to stabilize firm performance (Knecht, 2013).

There are two primary types of business diversification: related and unrelated. Firms may adopt either or both strategies, but the choice between them in response to growth volatility remains ambiguous. This study explores diversification choices under two scenarios: (i) when growth volatility increases, and (ii) when it decreases.

Baptista et al. (2020) argue from a resource-based perspective that young and small firms diversify to navigate unstable and uncertain markets. Building on this, we propose that when growth volatility rises, signaling heightened uncertainty and risk, managers are more likely to adopt related diversification as a strategic response. Increased volatility often drives managers to become more risk-averse (Comin & Philippon, 2005), prompting a focus on stabilizing operations by leveraging existing resources and capabilities. According to the theory of economies of scope, expanding product variety within related domains reduces average production costs by enabling firms to share common resources such as skills, technology, and infrastructure (Rumelt, 1982; Markides & Williamson, 1994). By diversifying into related areas, firms achieve operational synergies and cost efficiencies, enhancing their ability to adapt to volatile conditions. Related diversification provides an effective mechanism for firms to quickly utilize internal resources, stabilize operations, and maintain growth prospects in the face of uncertainty. This strategic choice reflects a focus on mitigating risk through resource optimization, making it a preferred approach for managers navigating periods of heightened growth volatility.

Diversification, however, is a long-term strategic activity. Managers' responses to growth volatility depend on the evolving nature of the situation. While some take immediate action, others implement changes more gradually. This reaction aligns with signaling theory and the theory of economies of scope, which collectively emphasize that managerial actions are shaped by observed volatility signals and resource optimization considerations. Based on these theories, this study proposes the following hypotheses:

A potential tension between the hypotheses developed here (H3/H4) and those on bankruptcy risk (H7) merits clarification. H3 and H4 describe the behavioural choice — what managers do when facing a volatility signal — whereas H7 describes the outcome — how that choice maps into bankruptcy risk. The two are not contradictory: managers may pursue related diversification even though it is associated with higher bankruptcy risk because it is the more accessible response under adjustment-cost and capability constraints (Penrose, 1959; Teece, 1980), because it is cognitively and operationally available in the sense of Upper Echelons Theory (Hambrick & Mason, 1984), and because institutional voids in emerging-market capital and managerial labour markets weaken the external discipline that would otherwise steer managers toward the more risk-optimal unrelated form (Khanna & Palepu, 2000). The empirically observed response to volatility can therefore differ from the risk-minimising one, which is precisely what the asymmetric mediation pattern in our results reflects.

H3: Current growth volatility is positively related to related business diversification.

H4: Past growth volatility is positively related to related business diversification.

When growth volatility decreases, it signals a more stable environment, reducing the urgency for firms to achieve cost savings through related diversification. In such conditions, managers may become more willing to accept risk (Comin & Philippon, 2005), shifting their focus toward opportunities for higher rewards. Lower volatility reduces uncertainty, making unrelated diversification a viable and attractive strategy. Studies by Bettis and Hall (1982) highlight that a greater appetite for risk encourages firms to pursue unrelated diversification. With lower perceived risk, firms are more inclined to invest in uncorrelated business activities, exploring new markets or industries that offer potential growth opportunities beyond their core operations. This shift reflects managers' willingness to capitalize on stable conditions to diversify strategically. Accordingly, this study proposes the following hypotheses:

H5: Current growth volatility is negatively related to unrelated business diversification.

H6: Past growth volatility is negatively related to unrelated business diversification.

Diversification: The effect on bankruptcy risk

Corporate diversification as a means to reduce firm risk is a motive often cited in the finance literature (Knecht, 2013). Two primary research directions investigate the impact of business diversification on bankruptcy risk. The first examines the overall effect of business diversification on bankruptcy risk, without distinguishing between types of diversification. The second investigates the specific components of diversification, namely related and unrelated diversification.

In the first approach, studies focus on the general role of business diversification in influencing bankruptcy risk. In this context, we explore three main theories to elucidate the impact: the coinsurance effect, modern portfolio theory, and the agency problem.

In an early paper on coinsurance, Lewellen (1971) posits that diversified firms have a lower probability of bankruptcy in the presence of capital market imperfections. Hann et al. (2013) support this notion, suggesting that business-segment diversification induces a coinsurance effect across segments, thereby reducing the cost of equity capital by mitigating systematic risk associated with the business cycle. Similarly, Singhal and Zhu (2013) and Faraji and Fleischhacker (2020) highlight that corporate diversification can diminish the risk

of financial distress when there is an imperfect correlation among the cash flows of a multi-segment firm.

Modern portfolio theory (Markowitz, 1952) suggests that diversification mitigates risk by distributing investments across uncorrelated sectors, minimizing the impact of any single sector's downturn. Pandya and Rao (1998) find that highly diversified firms exhibit lower returns with significantly reduced variance. However, the applicability of portfolio theory to corporate diversification is contested (Knecht, 2013). Combining different business units within a firm's portfolio can reduce overall risk, provided that the cash flows of the individual businesses are not perfectly positively correlated. Capital markets may value this risk reduction because it reduces the likelihood of bankruptcy by reducing fluctuations in firm cash flows. The risk reduction is particularly promising for unrelated diversification due to the presumably lower correlations between the cash flows of unrelated businesses. As a result, it may not be appropriate to use this theory to assert that related diversification reduces the risk of bankruptcy. Lubatkin and Chatterjee (1994) also argue that applying portfolio theory to justify diversification as a risk-reducing strategy is unconvincing.

The agency problem, which stems from managers' personal interests, serves as another incentive for firm diversification. To avoid the personal cost of failure, managers may diversify the firm to reduce the risk of failure, thereby safeguarding or increasing their compensation and ensuring their job security. Consequently, they may make diversification decisions that serve their financial interests but offer no benefits to shareholders (Faraji & Fleischhacker, 2020). When managers base diversification decisions on personal interests, it is highly likely that these decisions will result in reduced firm value and increased risks (Faraji & Fleischhacker, 2020).

However, a component-level analysis reveals asymmetric effects. Lubatkin and Chatterjee (1994) argue that related diversifiers benefit from synergistic interrelationships that reduce operational risks, whereas unrelated diversifiers lack such synergies, potentially increasing unsystematic risk. Their conclusion, that diversifying into similar businesses minimizes risk, contrasts sharply with portfolio theory.

Mammen et al. (2021) argue from the resource-based view (RBV) that product diversity reduces business risk, with related diversification providing greater risk mitigation compared to unrelated diversification. However, other studies challenge this perspective. Bettis and Hall (1982), who examined the relationship between diversification and accounting risk, found that related diversification tends to increase accounting risk, whereas unrelated diversification reduces it, a finding corroborated by Thanh et al. (2021).

This paper aligns more closely with the perspectives of Bettis and Hall (1982) and Thanh et al. (2021) and proposes that (i) the bankruptcy risk of a firm is likely to increase as it expands its related business activities, and (ii) this risk may decrease if the firm increases its level of unrelated business activities. By dividing diversification into two main components, related diversification and unrelated diversification, the relationship between diversification and risk mirrors the relationship between a portfolio and risk. Portfolio theory suggests that diversification reduces risk by spreading exposure across uncorrelated assets. Similarly, unrelated diversification mitigates firm-level risk by distributing exposure across unconnected industries. In contrast, related diversification, while leveraging synergies and shared resources, exposes firms to correlated risks, which can amplify financial vulnerabilities. Based on this reasoning, the study formulates the following hypotheses:

H7: The risk of bankruptcy will increase if firms pursue related business diversification.

H8: The risk of bankruptcy will decrease if firms engage in unrelated business diversification.

The distinction between these two effects carries important implications for corporate financial sustainability. If related diversification amplifies bankruptcy risk while unrelated diversification reduces it, then the composition of a firm's diversification strategy, not merely its overall level, determines whether diversification contributes to or detracts from a firm's long-term financial viability and, by extension, its capacity to support sustainable economic development.

Building upon the direct effects hypothesized above, we further propose that diversification strategies serve as mediating mechanisms through which growth volatility indirectly influences bankruptcy risk. Drawing on the integrated theoretical framework, H9a posits that growth volatility prompts managers to pursue related diversification (H3), which in turn amplifies bankruptcy risk (H7), creating an indirect risk-amplifying pathway. H10a suggests that growth volatility may also influence unrelated diversification, which reduces bankruptcy risk (H8), potentially creating an indirect risk-mitigating pathway. The distinction between these indirect effects is critical: the net impact of growth volatility on bankruptcy risk depends not only on its direct effect but also on which diversification pathway dominates.

H9a: Related diversification mediates the positive relationship between current growth volatility and bankruptcy risk (i.e., GV → RDIV → Bankruptcy).

H9b: Related diversification mediates the positive relationship between past growth volatility and bankruptcy risk (i.e., L_GV → RDIV → Bankruptcy).

H10a: Unrelated diversification mediates the relationship between current growth volatility and bankruptcy risk (i.e., GV → UDIV → Bankruptcy).

H10b: Unrelated diversification mediates the relationship between past growth volatility and bankruptcy risk (i.e., L_GV → UDIV → Bankruptcy).

Three unresolved debates in the prior literature shape the present study. The first concerns the dominant mechanism through which diversification influences firm risk: coinsurance views (Lewellen, 1971) emphasise diversification as risk-reducing, whereas agency-cost views (Berger & Ofek, 1995) emphasise value-destroying empire-building, with the relative weight of each effect unresolved. The second concerns the asymmetry between related and unrelated diversification: resource-based and core-competence perspectives (Mammen et al., 2021) typically predict that related diversification dominates because of capability leverage, while empirical evidence on bankruptcy risk in emerging markets has been mixed and at times reversed (Bettis & Hall, 1982). The third

concerns context-dependence in crisis settings: Almaghrabi (2022) reports a coinsurance benefit of diversification during the COVID-19 disruption in developed markets, while Ye et al. (2025) document a risk-amplification effect in China — suggesting that the institutional environment, particularly the depth of capital markets and the development of managerial labour markets, mediates the diversification-risk relationship. The present study advances these debates by separating diversification into related and unrelated components, modelling them as parallel mediators of growth volatility, and providing evidence from a frontier-market setting that systematically combines features of both developed and emerging-market contexts.

An Integrated Analytical Framework

The theoretical perspectives invoked above — signaling theory, Upper Echelons Theory, the theory of economies of scope, and portfolio theory — are not interchangeable lenses on the same phenomenon; rather, they correspond to a sequence of mechanisms that together explain why growth volatility produces asymmetric bankruptcy-risk consequences through related and unrelated diversification. The first mechanism is a *trigger*. Under signaling theory (Ross, 1977; Spence, 1973), growth volatility serves as an observable signal of underlying instability that managers, investors, and creditors all monitor. Higher volatility leads stakeholders to update their assessments of risk upward — managers feel pressure to respond strategically, while investors and creditors raise required risk premia. Both responses tend to increase the probability of financial distress in the short run.

The second mechanism is a choice. Once managers perceive the volatility signal, Upper Echelons Theory (Hambrick & Mason, 1984) explains how their cognitive and experiential filters channel the response toward strategic options that are cognitively and operationally available, while the theory of economies of scope (Panzar & Willig, 1981; Teece, 1980) explains why related diversification is the more accessible such option. Related diversification leverages existing resources, capabilities, and managerial routines, implying lower adjustment costs and shorter implementation horizons. Unrelated diversification, by contrast, requires acquiring or developing distant capabilities, with substantially higher adjustment costs and longer time-to-effectiveness. When firms must respond to a current volatility signal, the theory of economies of scope therefore predicts a tilt toward related rather than unrelated diversification — a prediction borne out by the H3/H5 contrast in our results.

The third mechanism is an *outcome filter*. Portfolio theory (Lewellen, 1971; Markowitz, 1952) implies that the risk-mitigating value of diversification depends not on its level but on the correlation structure of the diversified cash flows. Related segments share common drivers — overlapping suppliers, customers, technology cycles, and regulatory exposure — so their cash flows remain highly correlated and the coinsurance effect is weak. Unrelated segments draw on distinct demand and supply environments, so their cash flows are more nearly uncorrelated and the coinsurance effect operates as portfolio theory predicts. The outcome filter therefore separates two diversification choices that look similar in aggregate exposure but differ sharply in their consequences for bankruptcy risk.

Together, these three mechanisms form an analytical chain: growth volatility *signals* risk → managers *choose* diversification mode under adjustment-cost logic → choices produce *asymmetric outcomes* through different cash-flow correlation structures. This integrated logic generates a prediction that no single theory can produce on its own: not just that growth volatility affects bankruptcy risk, but that the indirect effect should be positive through related diversification (because of weak coinsurance under correlated cash flows) and negative through unrelated diversification (because of strong coinsurance under uncorrelated cash flows). The remainder of the paper tests this prediction empirically. The mediation hypotheses (H9a–H10b) therefore test whether diversification choices operate as the mechanisms through which growth volatility is converted into bankruptcy risk, rather than simply documenting separate direct relationships among the constructs.

Figure 1 presents the conceptual model, illustrating how growth volatility (current and lagged) influences related and unrelated business diversification, and in turn, affects bankruptcy risk. Collectively, these hypothesized

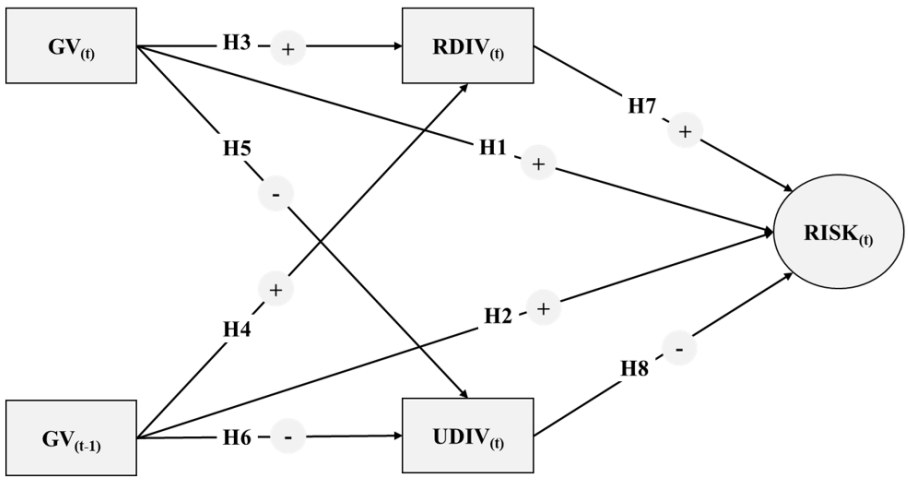


Figure 1. Conceptual model (Source: Authors' own elaboration)

Note: To avoid ambiguity in the placement of directional signs, the expected sign of each hypothesised path is summarised in **Table 1**; in the revised figure, each + or - sign is positioned directly adjacent to its corresponding path and away from crossing lines.

Table 1. The expected sign of each hypothesised path

Hypothesis	Path	Expected sign	Result
H1	GV → Bankruptcy risk	+	Supported
H2	L_GV → Bankruptcy risk	+	Not supported
H3	GV → Related diversification (RDIV)	+	Supported
H4	L_GV → Related diversification (RDIV)	+	Supported
H5	GV → Unrelated diversification (UDIV)	-	Not supported
H6	L_GV → Unrelated diversification (UDIV)	-	Supported
H7	RDIV → Bankruptcy risk	+	Supported
H8	UDIV → Bankruptcy risk	-	Supported
H9a	GV → RDIV → Bankruptcy risk	+	Supported
H9b	L_GV → RDIV → Bankruptcy risk	+	Not supported
H10a	GV → UDIV → Bankruptcy risk	-	Not supported
H10b	L_GV → UDIV → Bankruptcy risk	-	Not supported

Note: GV = growth volatility; L_GV = lagged growth volatility; RDIV = related diversification; UDIV = unrelated diversification; Bankruptcy = bankruptcy risk.

relationships form an integrated framework linking growth volatility, diversification strategies, and bankruptcy risk, providing a basis for examining the micro-level mechanisms through which firm-level instability may threaten corporate financial sustainability in an emerging-market context.

METHODS

Measurement

Bankruptcy risk

Bankruptcy risk is proxied by the one-year expected default frequency (EDF) estimated using the KMV-Merton model (Kealhofer & Bohn, 1998; McQuown, 1997; Vasicek, 1984). Following the structural approach, firm equity is treated as a call option on firm assets, and asset value (V) and asset volatility (σ_V) are inferred from observed equity value and equity volatility. We set $T = 1$to obtain the one-year EDF. The default point is defined as $Dpt = STD + 0.5LTD$, where STD and LTD denote short-term and long-term debt, respectively. Distance to default is calculated as $DD = [\ln(V/Dpt) + (r - 0.5\sigma_V^2)T]/(\sigma_V\sqrt{T})$, where r is the risk-free rate. The EDF is then computed as $EDF = \Phi(-DD)$. Throughout the paper, EDF is used as the measure of bankruptcy risk.

Firm growth volatility

As recommended by Coad et al. (2017), firm growth volatility is measured across four key dimensions, including assets, employment, sales, and operating profits volatility.

Several methods have been applied to measure volatility. The simplest and most conventional method involves using the standard deviation of growth rates. This approach has been adopted by authors such as Di Giovanni et al. (2014) and Sundaram (2019). While straightforward to compute, it requires large datasets with a normal distribution, which can be a limitation.

For panel data, growth volatility needs to be calculated for each firm across the observation period, which may be relatively short. Moreover, the data are subject to specific temporal and structural influences, requiring careful control for these factors. In this study, with data spanning 2013–2024, the traditional method is unsuitable. Therefore, this paper applies the residual approach, originally proposed by Morgan et al. (2004) and later developed by Kalemli-Ozcan et al. (2014). This approach has been used by other researchers such as Kurz and Senses (2016) or Sundaram (2019) when analyzing panel data.

Step 1: Component-wise Growth Calculation

The growth of each firm's components is determined logarithmically, as follows:

$$G_{j.it} = lnC_{j.it} - lnC_{j.it-1} \quad (1)$$

Where:

- j represents four dimensions, including assets, employment, sales, and operating profits growth volatility
- G_{jit} is the growth rate of dimension j for firm i in year t, calculated logarithmically.
- $C_{j.it}$ and C_{jit-1} represent dimension j of growth for firm i in years t and t-1.

Step 2: Identifying Residual Growth via Panel Data Modeling

The residual growth is extracted using a panel data model:

$$G_{j.it} = \alpha_i + \theta_t + e_{j.it} \quad (2)$$

Where:

- $\alpha_{j.i}$: Fixed effects representing time-invariant factors for firm i.
- $\theta_{j.t}$: Time effects representing changes that vary over time but are constant across firms, such as macroeconomic factors (e.g., inflation, interest rates, exchange rates).
- $e_{j.it}$: Residuals capturing firm-specific volatility due to output components (assets, employment, sales, and operating profits) relative to the average growth rate over the observed period.

This study uses Stata to estimate the fixed-effects model. Time effects are controlled by creating time dummy variables. After estimation, the residuals e_{it} are obtained.

Step 3: Calculating Growth Volatility

The growth volatility of each dimension for firm i at time t is calculated as:

$$GV_{j.it} = Vol(G_{j.it}) = |e_{j.it}| \quad (3)$$

Here, $GV_{j.it}$ represents the magnitude of volatility, derived from the absolute value of residuals $e_{j.it}$.

A natural concern with this measure is that absolute residuals could capture pure idiosyncratic noise rather than economically meaningful volatility. The three-step procedure above is designed precisely to address this concern. By residualising log-growth on entity fixed effects, the measure removes time-invariant heterogeneity across firms (size, sector, business model, founder identity); by adding time effects, it removes common shocks that move all firms together (macroeconomic cycles, the COVID-19 disruption, sector-wide trends). What remains in the residuals is firm-specific variation that cannot be explained by either persistent firm characteristics or aggregate factors. Following the firm-volatility literature, we interpret these residuals as the "unexpected" component of growth — that is, instability that managers, investors, and creditors would not have anticipated from the firm's systematic profile (Comin & Mulani, 2009; Comin & Philippon, 2005; Kalemli-Ozcan et al., 2014; Morgan et al., 2004). The absolute value transformation then converts deviations of either sign into a non-negative magnitude, consistent with the conceptual definition of volatility.

Several alternative volatility measures were considered and rejected as less suitable for the present research design. Rolling within-firm standard deviations require a sufficiently long time series and discard early observations through the rolling window, which is restrictive when the panel covers twelve years. GARCH-type specifications are designed for high-frequency series and are not well-suited to annual firm-year data with few observations per firm. The coefficient of variation does not separate systematic from idiosyncratic variation and confounds firm size effects with volatility. Squared rather than absolute residuals are conceptually similar but more sensitive to outliers, which is undesirable in a sample that includes COVID-19 disruption years. The residual-based absolute-deviation approach we adopt has been shown to be a robust firm-level volatility proxy in this literature (Morgan et al., 2004; Kalemli-Ozcan et al., 2014). A further practical advantage of the residual-based approach is that, because volatility is computed each year rather than over a long rolling window, it preserves firm-year observations from short-listed and delisted firms, mitigating the survivorship bias that affects rolling-SD measures requiring extended time series.

Finally, the present design extends earlier residual-based volatility studies, which typically focused on a single dimension such as earnings or sales volatility, to four theoretically grounded dimensions of firm growth. This multidimensional treatment is consistent with Coad et al. (2017) and is what allows growth volatility to be modelled as a formative construct rather than a single proxy variable.

In this study, GV is a construct measured by four dimensions (represented by C) which are described in **Table 2**. Hence, these four dimensions form the measurement model for GV.

Modelling growth volatility as a formative latent construct rather than as a single observed proxy is grounded in three considerations (Diamantopoulos & Winklhofer, 2001; Jarvis et al., 2003). First, the four dimensions (assets, employment, sales, and operating-profit volatility) capture different operational manifestations of underlying instability — they are "defining" rather than "reflective" indicators in the sense that the construct would change conceptually if any dimension were dropped. Second, the four dimensions are not interchangeable: a firm with high asset volatility but low sales volatility is not equivalent to a firm with the opposite pattern, even if their summary statistics on a single proxy were similar. Third, treating these four dimensions as a formative composite, with weights estimated endogenously and tested for significance, preserves more information than collapsing them into a single synthetic measure. The CTA-PLS test reported in Section *Confirmatory Tetrad Analysis and Measurement Model Assessment* provides empirical confirmation that a formative specification is statistically appropriate for these four indicators in our data.

Table 2. Four dimensions of firm growth-level volatility

Variable	Label
Labour growth volatility	LGV
Assets growth volatility	AGV
Sales growth volatility	SGV
Operating profits growth volatility	PGV

The confirmatory tetrad analysis (CTA-PLS) proposed by Bollen and Ting (2000) is used to statistically check whether this measurement model is reflective or formative. If the results indicate that a formative measurement model is appropriate, additional evaluations of the measurement model will be conducted, including those for convergent validity, the degree of multicollinearity between the variables, and the level of statistical significance of each regression weight, following Hair et al. (2021).

Business diversification

According to Knecht (2013), there are two methods to assess diversification: continuous measurements and categorical measures. The entropy measure is classified as a continuous measure that is included in the entropy calculation along with category measures and business count measures. Jacquemin and Berry (1979) were the first authors to suggest utilizing entropy as a method for quantifying the level of diversification. Knecht (2013) concludes that this measure has been extensively used throughout the literature and found to be more valid than other measures of diversification. The entropy measure, as expressed below, captures both related and unrelated diversification.

Related diversification:

$$RDiv = \sum_{r=1}^{r} p_r \, log_2(\frac{1}{p_r}) \quad (4)$$

in which r is the r^{th} segment related to the primary business, and p_r is the ratio of the sale of the r^{th} segment to total sales.

Unrelated diversification:

$$UDiv = \sum_{u=1}^{u} p_u \, log_2(\frac{1}{p_u}) \quad (5)$$

in which u is the u^{th} segment unrelated to the primary business, and p_u is the ratio of the sale of the r^{th} segment to total sales.

Estimation Method

Structural equation modelling

This study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to simultaneously analyze multiple relationships among five constructs: GV, L_GV, RDIV, UDIV, and Bankruptcy (Guenther et al., 2023; Rigdon et al., 2017). PLS-SEM is preferred over covariance-based SEM (CB-SEM) for four reasons (Guenther et al., 2023; Hair et al., 2022): (i) the study proposes a new theoretical framework requiring exploratory testing rather than confirmatory analysis; (ii) growth volatility is measured as a formative construct with four indicators, validated through CTA-PLS; (iii) the model incorporates single-item constructs (RDIV, UDIV, Bankruptcy), which PLS-SEM handles effectively; and (iv) PLS-SEM does not rely on strict distributional assumptions, providing greater flexibility for our data. This methodological choice is consistent with recent applications of PLS-SEM in corporate finance and sustainability research (Habib, 2023).

We emphasise upfront that the use of PLS-SEM here should not be interpreted as a substitute for the full set of panel-econometric estimators (OLS-FE, GMM, dynamic panel methods), nor as a claim of definitive causal identification. Beyond these standard considerations, four substantive features of the present research design make PLS-SEM a particularly appropriate estimator rather than a reduced-form linear panel method.

First, *growth volatility is a formative composite, not a single observed regressor*. Following Coad et al. (2017), GV is defined by four constituent dimensions — assets, employment, sales, and operating-profit volatility — that jointly constitute the construct rather than reflect a common underlying factor (verified by CTA-PLS in **Table 5**). A reduced-form OLS-FE or GMM specification must collapse these four dimensions into a single proxy a priori, which discards information about the construct's multidimensional structure and hard-codes equal weights. PLS-SEM, by contrast, estimates dimension weights endogenously together with their significance tests, preserving the formative definition.

Second, *the model contains four parallel mediation pathways tested simultaneously* (H9a, H9b, H10a, H10b). Sequential causal-step procedures (Baron & Kenny, 1986) are not appropriate for testing multiple mediators simultaneously, because they cannot jointly evaluate competing indirect effects nor produce valid bootstrap inference for the full set of indirect coefficients. PLS-SEM bootstrap mediation tests are the current standard for such structures (Hair et al., 2022).

Third, *Equations (6)–(8) constitute a system with three endogenous variables* (RDIV, UDIV, Bankruptcy). Estimating each equation separately by OLS or GMM would ignore the system structure and the cross-equation links implied by the mediation hypotheses; PLS-SEM treats the equations as a coupled system, which is the theoretically consistent estimator for our structural model.

Fourth, *the panel structure is addressed via demeaning* (Thanh & Ha, 2019; see Section *Panel data in an SEM model*). Subtracting entity-specific means from all variables eliminates time-invariant unobserved firm heterogeneity in a manner analogous to the within-transformation underlying the fixed-effects estimator. The present specification is therefore not a "pure" cross-sectional SEM but a panel-adapted PLS-SEM in which the principal source of unobserved heterogeneity has already been differenced out before structural estimation.

While linear panel methods (OLS-FE, GMM) are powerful for identifying single-equation causal effects, they are not designed to test formative composites within a system of structural equations containing multiple parallel mediators. To further protect inference against method-specific artefacts, we replicate the analysis with an alternative accounting-based bankruptcy proxy (Altman Z-score, Section *Alternative dependent variable*) and conduct PLS-SEM-specific robustness checks for endogeneity, unobserved heterogeneity, and non-linearity (Section *Robustness check in PLS-SEM framework*). The substantive conclusions are stable across these checks, indicating that they are unlikely to be artefacts of the PLS-SEM choice. Accordingly, the structural estimates are interpreted as robust conditional associations within an integrated path model, rather than as fully causal estimates in the strict econometric sense.

The equations of the structural model

The relationship between latent variables in the statistical model is represented by the following equations:

$$\begin{cases} RDiv = \hat{\beta}_{01} + \hat{\beta}_{11}GV + \hat{\beta}_{21}L_GV + e_1 & (6) \\ UDiv = \hat{\beta}_{02} + \hat{\beta}_{12}GV + \hat{\beta}_{22}L_GV + e_2 & (7) \\ Bankruptcy = \hat{\beta}_{03} + \hat{\beta}_{13}GV + \hat{\beta}_{23}L_{GV} \\ \quad +\hat{\beta}_{33}RDiv + \hat{\beta}_{43}UDiv + e_3 & (8) \end{cases}$$

These equations outline a path model consisting of three endogenous variables: RDiv, UDiv, and Bankruptcy. Equations (6) and (7) illustrate the effects of GV and L_GV on RDiv and UDiv, respectively. Equation (8) captures the influence of GV, L_GV, RDiv, and UDiv on Bankruptcy. Additionally, the equations reveal the indirect impact of RDiv and UDiv on the relationship between GV, L_GV, and Bankruptcy.

Panel data in an SEM model

Panel data contain unobserved individual-specific and time-specific fixed effects (Baltagi, 2021). To address this in PLS-SEM, we apply the demeaning method (Thanh & Ha, 2019), which subtracts entity-specific means from all variables, effectively eliminating individual fixed effects and ensuring unbiased estimation. Time effects are controlled through year dummy variables. Two further longitudinal-data concerns warrant explicit treatment in this PLS-SEM environment. First, regarding autocorrelation, the demeaning procedure eliminates persistent firm-level effects, and the addition of year dummies absorbs common time-varying shocks; the residual time-series dependence is further addressed by computing standard errors via cluster-bootstrap by firm with 10,000 resamples, which provides inference that is robust to within-firm serial correlation in the structural residuals (Sarstedt et al., 2020). Second, regarding heteroskedasticity, PLS-SEM path estimates are consistent under heteroskedasticity (Hair et al., 2022), and the bootstrap

Table 3. Descriptive statistics

Label	Variable	Min.	Max.	Mean	SD
EDF	Bankruptcy risk	0.013	0.691	0.212	0.161
RDIV	Related business diversification	0.002	1.222	0.712	0.417
UDIV	Unrelated business diversification	0.003	1.112	0.568	0.221
LGV	Labour growth volatility	0.011	1.112	0.219	0.078
AGV	Assets growth volatility	0.037	1.738	0.433	0.281
SGV	Sales growth volatility	0.021	2.207	0.525	0.401
PGV	Operating profit growth volatility	0.013	2.113	0.519	0.379

procedure used here does not assume homoskedastic residuals, so its inferential validity is preserved under the heteroskedastic conditions typical of firm-level panel data. Together, these features ensure that the PLS-SEM estimates produced after the demeaning step accommodate the standard panel-data concerns of unobserved heterogeneity, autocorrelation, and heteroskedasticity within an integrated estimation framework.

Data

This study uses an unbalanced panel of non-financial firms listed on Vietnam's stock exchanges from 2013 to 2024. The sample covers firms listed on the Ho Chi Minh Stock Exchange (HOSE) and the Hanoi Stock Exchange (HNX) and yields 5,325 firm-year observations for 485 firms. Vietnam provides a relevant emerging-market setting because its stock market has experienced rapid expansion together with substantial firm-level instability during the study period, including a considerable number of involuntary delistings (To, 2025; Vuong et al., 2024).

Firms were included if they were classified under the Global Industry Classification Standard (GICS), operated outside the financial sector, and had sufficient data to construct the study variables. Importantly, the sample was not restricted to firms continuously listed throughout the entire 2013–2024 period. Instead, it retains firms that were delisted during the sample window and uses all available firm-year observations up to the delisting year or the end of the study period. This sampling choice is intentional, as excluding delisted firms would mechanically remove financially vulnerable observations and may induce survivorship bias in a study of bankruptcy risk.

A natural question concerns whether the structural estimates may be biased by omitted control variables such as firm size, firm age, leverage, ownership structure, or industry-specific factors. Our research design addresses this concern through three complementary mechanisms rather than the explicit inclusion of additional control variables. First, the demeaning procedure (Section *Panel data in an SEM model*) eliminates all time-invariant firm characteristics — including size at listing, ownership-structure baseline, sector classification, and business-model fundamentals — in a manner equivalent to the within-transformation underlying a fixed-effects estimator (Wooldridge, 2010). Second, year dummies absorb common time-varying shocks such as macroeconomic cycles, regulatory changes, and the COVID-19 disruption, isolating firm-specific variation. Third, each firm acts as its own control across the 12-year panel: the structural relationships are identified from within-firm variation rather than from cross-sectional differences, which limits the influence of stable cross-sectional confounders. The principal residual concern is time-varying firm-specific factors that are correlated with both volatility and bankruptcy risk (e.g., year-over-year changes in leverage). We discuss this in Section *Limitations and Future Research* as a limitation, and we expect that future research incorporating explicit time-varying controls will provide an additional layer of robustness to the present results.

EMPIRICAL RESULTS AND DISCUSSION

Descriptive Statistics

Table 3 reports the descriptive statistics for the study variables, while **Table 4** presents their yearly patterns over 2013–2024. Bankruptcy risk (EDF) has a mean of 0.212 and a standard deviation of 0.161, indicating substantial cross-firm variation in default risk. Related diversification (RDIV) records a mean of 0.712 (SD = 0.417), which is higher than unrelated diversification (UDIV) with a mean of 0.568 (SD = 0.221), suggesting that, on average, the sampled firms rely more on related than unrelated diversification. Among the four growth-volatility dimensions, sales growth volatility (SGV; mean = 0.525, SD = 0.401) and operating profit growth volatility (PGV; mean = 0.519, SD = 0.379) show the highest average levels, followed by assets growth volatility (AGV; mean = 0.433, SD = 0.281), whereas labour growth volatility (LGV; mean = 0.219, SD = 0.078) is comparatively lower. These descriptive levels carry substantive interpretive content for the Vietnamese setting. The relatively higher mean of RDIV compared with UDIV is consistent with a portfolio of firms that, on average, expand into related rather than unrelated activities — a pattern characteristic of emerging-market firms operating under institutional voids in capital, labour, and product markets (Khanna & Palepu, 2000). Volatility levels across the four dimensions (LGV, AGV, SGV, PGV) reflect the combined influence of macroeconomic exposure, sectoral dynamics, and firm-specific instability against a backdrop of banking-sector reform, equitisation of state-owned enterprises, and external shocks — most prominently the COVID-19 disruption — over the 2013–2024 period.

Table 4 shows several notable time-series patterns. Bankruptcy risk declines from 0.25 in 2013 to 0.13 in 2019, rises sharply to 0.32 in 2021, and then moderates to 0.25 by 2024. RDIV generally decreases during 2013–2020 before increasing markedly in 2021–2023 and easing slightly in 2024, whereas UDIV exhibits an overall upward tendency over the sample period, although the increase is not monotonic. For the volatility measures, LGV remains the lowest across years, while AGV, SGV, and PGV show stronger fluctuations, especially during 2020–2022. Overall, these descriptive

Table 4. Trends in growth-volatility dimensions (LGV, AGV, SGV, PGV), RDIV, UDIV, and bankruptcy risk (EDF) from 2013 to 2024

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
EDF	0.25	0.25	0.29	0.21	0.18	0.14	0.13	0.17	0.32	0.29	0.26	0.25
RDIV	0.76	0.72	0.65	0.66	0.61	0.62	0.67	0.59	0.67	0.78	0.98	0.87
UDIV	0.45	0.51	0.54	0.57	0.57	0.52	0.62	0.63	0.64	0.68	0.61	0.63
LGV	0.23	0.1	0.15	0.15	0.21	0.24	0.17	0.25	0.31	0.33	0.29	0.31
AGV	0.42	0.41	0.55	0.43	0.26	0.29	0.25	0.45	0.65	0.54	0.32	0.35
SGV	0.62	0.37	0.41	0.42	0.52	0.48	0.41	0.53	0.62	0.71	0.61	0.64
PGV	0.44	0.29	0.24	0.54	0.56	0.49	0.52	0.63	0.71	0.63	0.53	0.56

patterns provide preliminary evidence of variation in both diversification strategies and bankruptcy risk, thereby motivating the subsequent multivariate analysis. Linking these trends to major economic events provides further context. The gradual decline in EDF from 0.25 in 2013 to 0.13 in 2019 coincides with the period of macroeconomic stabilisation following the post-2012 banking-sector reform and the introduction of stricter listing requirements on HOSE and HNX. The sharp EDF spike in 2021 (rising to 0.32) closely tracks the COVID-19 disruption, when both production halts and supply-chain interruptions impaired firm-level cash flows. The post-2021 increase in RDIV is consistent with consolidation responses, in which firms expanded into related activities to leverage existing capabilities and stabilise cash flows during a recovery characterised by domestic-demand reorientation. These contextual readings reinforce the interpretation that the variation in growth volatility and diversification observed in the panel is not statistical noise but reflects firm-level adjustment to identifiable macro-institutional events.

Before proceeding to the structural analysis, we note three features of the data distribution. First, the four growth-volatility dimensions are non-normally distributed (Cramér–von Mises and Kolmogorov–Smirnov tests reject normality at the 1% level), which is consistent with the firm-level volatility literature and is also a prerequisite for the Gaussian copula endogeneity test reported in Section *Robustness check in PLS-SEM framework* part (i). Second, to mitigate the influence of extreme observations, all continuous variables are winsorised at the 1st and 99th percentiles before estimation. Third, non-normality is not a concern for the structural estimation itself: PLS-SEM does not assume multivariate normality of the constructs, which is in fact one of the methodological reasons for preferring it over CB-SEM in this setting (Hair et al., 2022).

Confirmatory Tetrad Analysis and Measurement Model Assessment

Confirmatory tetrad analysis

As noted earlier, growth volatility is evaluated across four dimensions: LGV, AGV, SGV, and PGV. To statistically validate the measurement model for growth volatility, this study utilizes CTA-PLS (Confirmatory Tetrad Analysis) as proposed by Bollen and Ting (2000).

The findings in **Table 5** demonstrate that all p-values are less than 0.05; hence, the suggested measurement model is appropriate. **Table 5** reports CTA-PLS results under two indicator-order permutations (a software artifact), and both specifications support a formative measurement model. Since the theoretical substance of the study and the statistical evidence are consistent, we employ a formative measurement model to measure growth volatility.

Table 5. Confirmatory tetrad analysis (CTA-PLS) results

Growth volatility	*P*-values	Model
1: AGV,LGV,PGV,SGV	0.03	Formative
2: AGV,LGV,SGV,PGV	0.013	Formative

Measurement model assessment

Following the CTA-PLS results, the measurement model was assessed. RDIV, UDIV, and Bankruptcy are operationalized as single-item constructs; therefore, internal consistency reliability and inter-item validity assessments are not applicable. By contrast, GV is specified as a formative construct composed of AGV, LGV, SGV, and PGV. Consistent with Benitez et al. (2020), its assessment focuses on convergent validity, collinearity among indicators, and the significance of outer weights.

Before discussing the empirical results, we briefly motivate two design choices underlying the measurement model assessment. First, growth volatility is modelled as a formative composite because the four constituent dimensions — assets, employment, sales, and operating-profit volatility — define rather than reflect the construct: removing any one dimension would change the conceptual content of growth volatility, and the four dimensions are not interchangeable indicators of a common underlying factor (Diamantopoulos & Winklhofer, 2001; Jarvis et al., 2003). This specification choice is empirically validated by the CTA-PLS results in **Table 5**. Second, in the redundancy analysis we use stock return volatility as the global single-item criterion because it represents a market-based aggregate of firm-level instability that, by construction, incorporates information from all four operational dimensions of growth volatility (Fama & French, 1992; Onali & Mascia, 2022). Investors integrate multiple sources of firm-level volatility into stock prices, making stock return volatility a theoretically suitable global proxy for the formative construct.

Convergent validity was examined using the redundancy analysis approach recommended by Chin (1998), in which GV predicts a global single-item criterion measured by stock return volatility. As shown in **Figure 2**, the model yields an R^2 value of 0.664, exceeding the recommended threshold of 0.50 and supporting the convergent validity of the formative construct. Multicollinearity is not a concern, as the VIF values for AGV, LGV, PGV, and SGV are 1.116, 1.271, 1.435, and 1.113, respectively, all well below the threshold of 5 (**Table 6**). In addition, all outer weights are positive and statistically significant at the 5% level (**Table 7**), indicating that each indicator contributes meaningfully to the formation of GV.

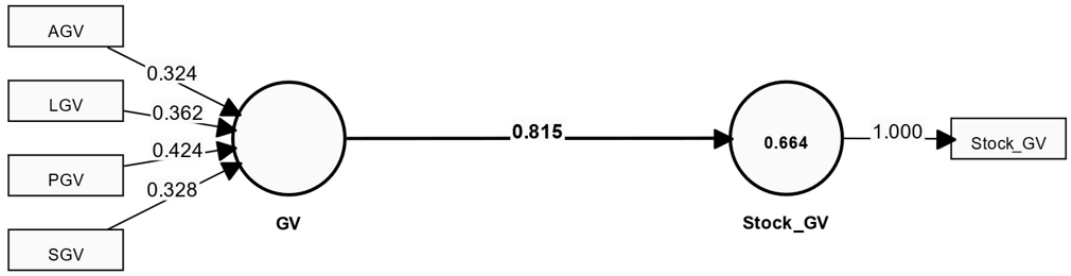


Figure 2. Convergent validity (Source: Authors' own elaboration)
Note. GV = growth volatility; L_GV = lagged growth volatility; RDIV = related diversification; UDIV = unrelated diversification; Bankruptcy = bankruptcy risk.

Table 6. VIF coefficients

Variable	VIF
AGV	1.116
LGV	1.271
PGV	1.435
SGV	1.113

Table 7. The significance of outer weights

	Outer weights	T Statistics	P-Values
LGV -> GV	0.19	9.81	0.000
AGV -> GV	0.25	10.11	0.000
SGV -> GV	0.32	12.705	0.000
PGV -> GV	0.18	9.762	0.000

Therefore, all four indicators are retained for the subsequent structural analysis.

Structural Model Assessment

The study follows the guidelines provided by Benitez et al. (2020) to conduct key evaluations of the PLS-SEM structural model, including assessments of multicollinearity (VIF), the coefficient of determination (R^2), and the significance of the path coefficients.

Table 8. VIF matrix

	RDIV	UDIV	Bankruptcy
GV	1.01	1.01	1.038
L_GV	1.01	1.01	1.028
RDIV			1.035
UDIV			1.036

The multicollinearity assessment, shown in **Table 8**, was conducted using the Variance Inflation Factor (VIF). The results indicate no significant multicollinearity concerns, as all VIF values are below the acceptable threshold of 5, confirming the independence of the predictors. The coefficient of determination (R^2) values highlight the model's explanatory power, with R^2 values of 0.318 for bankruptcy risk, 0.221 for related diversification, and 0.113 for unrelated diversification (see **Table 9**).

Next, we perform a bootstrapping test to assess the significance of coefficients. **Figure 3** shows the result of the structural model.

Table 9. Coefficient of determination (R^2) and predictive relevance (Q^2)

	R-square	R-square adjusted	Q^2	Interpretation
Bankruptcy	0.318	0.304	0.176	Predictive relevance
RDIV	0.221	0.211	0.118	Predictive relevance
UDIV	0.113	0.102	0.047	Weak predictive relevance

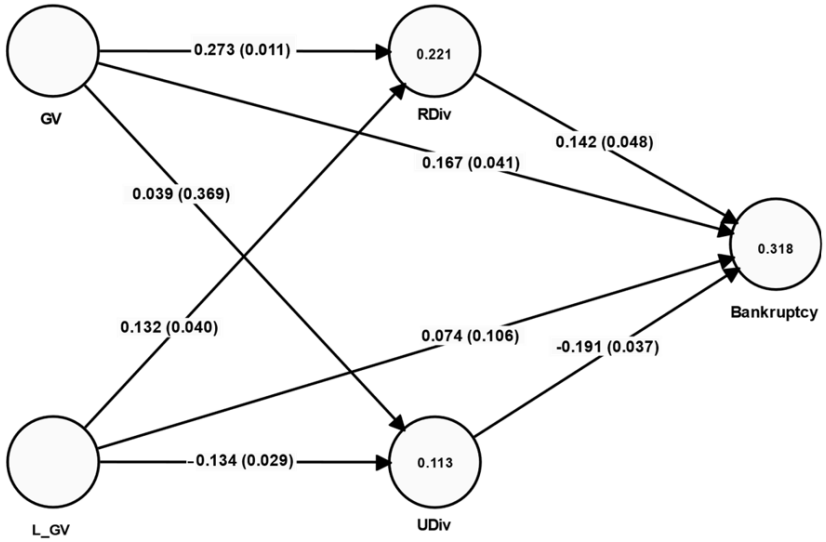


Figure 3. Estimated results of the structural model (Source: Authors' own elaboration)
Note. GV = growth volatility; L_GV = lagged growth volatility; RDIV = related diversification; UDIV = unrelated diversification; Bankruptcy = bankruptcy risk.

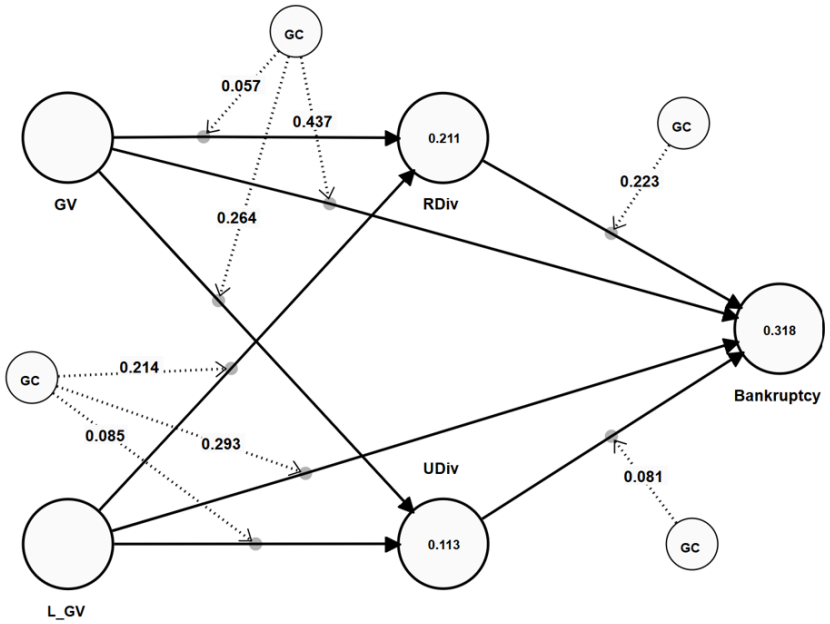


Figure 4. Assessment of endogeneity: Gaussian Copula Approach (Source: Authors' own elaboration)
Note. GV = growth volatility; L_GV = lagged growth volatility; RDIV = related diversification; UDIV = unrelated diversification; Bankruptcy = bankruptcy risk.

The bootstrapping results of the PLS-SEM analysis are summarized in **Figure 4**, showcasing the significance and strength of the relationships among the model variables. Path coefficients are presented with their corresponding p-values in parentheses. At the 5% significance level, the following paths are statistically significant: GV → Bankruptcy (β = 0.167, p = 0.041), GV → RDIV (β = 0.273, p = 0.011), L_GV → RDIV (β = 0.132, p = 0.040), L_GV → UDIV (β = -0.134, p = 0.029), RDIV → Bankruptcy (β = 0.142, p = 0.048), and UDIV → Bankruptcy (β = -0.191, p = 0.037). The path L_GV → Bankruptcy (β = 0.074, p = 0.106) does not reach conventional significance at the 5% level. The path GV → UDIV (β = 0.039, p = 0.369) is not statistically significant.

The model's explanatory power is captured by the R^2 values, where RDIV accounts for 22.1%, UDIV accounts for 11.3%, and Bankruptcy explains 31.8% of the variance. These findings highlight that growth volatility (GV) and lagged growth volatility (L_GV) significantly impact related diversification (RDIV), while unrelated diversification (UDIV) and related diversification influence bankruptcy risk, with UDIV showing a negative effect. Overall, the results are consistent with the proposed relationships and the theoretical framework, while also identifying non-significant paths that may warrant further investigation. Taken together with the pattern of significant and non-significant paths, the results provide partial support for the proposed framework: several hypothesised relationships are statistically supported, while the non-significant paths suggest that the relationships are conditional rather than uniform across diversification modes and time horizons. To complement the R^2 values, we additionally report effect sizes (f^2) and predictive relevance (Q^2) for the structural model. As shown in **Table 9**, the Q^2 values are positive for all three endogenous constructs (RDIV: 0.118; UDIV: 0.047; Bankruptcy: 0.176), confirming the predictive relevance of the model, with predictive relevance for UDIV being weaker — consistent with its lower R^2 and the non-significant GV → UDIV path. **Table 10** reports the f^2 effect sizes for each predictor; following Cohen (1988), the individual effects are generally small in magnitude, with the largest contribution observed for GV → RDIV (f^2 = 0.075, small-to-moderate) and the smallest for GV → UDIV (f^2 = 0.002, negligible). These small-magnitude effects are consistent with the nature of firm-level bankruptcy-risk modelling, in which a multitude of factors contribute jointly. Beyond statistical significance, the economic significance is best appreciated through standardised path coefficients: a one-standard-deviation increase in current GV is associated with approximately a 0.17-standard-deviation increase in bankruptcy risk and a 0.27-standard-deviation increase in RDIV — both translating into economically meaningful shifts in firm-level default probability when applied to the EDF distribution observed in the Vietnamese sample. The asymmetric direct effects of RDIV (β = 0.142) and UDIV (β = -0.191) on bankruptcy risk imply that two firms identical in all other respects but differing by one standard deviation in their RDIV–UDIV mix face materially different default probabilities, reinforcing the practical importance of diversification composition rather than diversification level.

Table 10. Effect sizes (f^2)

Endogenous construct	Predictor	f^2	Interpretation
RDIV	GV	0.075	Small-to-moderate
RDIV	L_GV	0.023	Small
UDIV	GV	0.002	Negligible
UDIV	L_GV	0.027	Small
Bankruptcy	GV	0.038	Small
Bankruptcy	L_GV	0.009	Negligible
Bankruptcy	RDIV	0.026	Small
Bankruptcy	UDIV	0.051	Small

Table 11. Results of direct effects

Hypothesis	Path	Original sample	Sample mean	t-statistics	p-values	2.5%	97.5%	Decision
H1	GV → Bankruptcy	0.167	0.159	2.06	0.041	0.111	0.201	Supported
H2	L_GV → Bankruptcy	0.074	0.064	1.62	0.106	-0.113	0.153	Not supported
H3	GV → RDIV	0.273	0.282	2.56	0.011	0.197	0.418	Supported
H4	L_GV → RDIV	0.132	0.139	2.06	0.040	0.096	0.257	Supported
H5	GV → UDIV	0.039	0.035	0.90	0.369	-0.152	0.284	Not supported
H6	L_GV → UDIV	-0.134	-0.131	2.19	0.029	-0.312	-0.098	Supported
H7	RDIV → Bankruptcy	0.142	0.154	1.98	0.048	0.101	0.235	Supported
H8	UDIV → Bankruptcy	-0.191	-0.184	2.10	0.037	-0.286	-0.085	Supported

Note. GV = growth volatility; L_GV = lagged growth volatility; RDIV = related diversification; UDIV = unrelated diversification; Bankruptcy = bankruptcy risk.

Results Discussion

Direct effects discussion

Table 11 reports the direct effects among growth volatility, diversification strategies, and bankruptcy risk. The positive and significant effect of current growth volatility (GV) on bankruptcy risk supports H1, whereas the non-significant direct effect of lagged growth volatility (L_GV) on bankruptcy risk does not support H2. This finding is consistent with recent evidence from Vietnam showing that greater stock return volatility increases financial distress among listed firms (Vuong et al., 2024). It also aligns with the broader view that the financial consequences of volatility are shaped by institutional conditions, which is especially relevant in emerging markets (Zouaghi et al., 2024). From the perspective of signaling theory, current growth volatility is consistent with functioning as an immediate warning signal to investors and creditors, thereby being associated with greater perceived firm risk and financial vulnerability. By contrast, the lack of support for H2 suggests that the direct effect of past volatility on current bankruptcy risk may weaken over time once firms adjust operationally and stakeholders incorporate earlier information into their expectations.

The results for diversification choices provide support for H3, H4, and H6, but not for H5. Specifically, current GV is positively associated with related diversification (RDIV), supporting H3, while its effect on unrelated diversification (UDIV) is not statistically significant, leading to rejection of H5. In addition, L_GV is positively associated with RDIV and negatively associated with UDIV, supporting H4 and H6, respectively. These findings suggest that when firms face instability, they tend to respond through strategically closer activities rather than through broader cross-industry expansion. This interpretation is consistent with the Theory of Economies of Scope and also resonates with recent empirical evidence showing that the consequences of diversification under major shocks are heterogeneous. For example, business diversification was found to increase stock risk during the COVID-19 shock in a global setting (Onali & Mascia, 2022), whereas other studies suggest that diversified firms may perform better in crisis periods when internal capital markets and resource redeployment mechanisms are effective (Chen & Nguyen, 2025; Wang, 2023). Against this background, the current results suggest that diversification is not uniformly stabilizing; rather, firms appear to favor related diversification as a more feasible response to volatility, while prior instability discourages unrelated diversification. The non-significant H5 path (current GV → UDIV) deserves further interpretation because it offers a distinctive insight into the strategic behaviour of Vietnamese firms. Unlike related diversification, which can be initiated quickly by leveraging existing capabilities, unrelated diversification requires longer planning horizons, additional capital, and the acquisition of new managerial and technical capabilities. From an Upper Echelons perspective (Hambrick & Mason, 1984), such moves cannot be executed within the same observation window in which a volatility signal is received. The negative and significant L_GV → UDIV coefficient (H6) is consistent with this interpretation: after a delay of one year, firms appear to retreat from unrelated diversification activities once volatility persists, possibly to consolidate resources around their core business. In the institutional context of Vietnam — characterised by concentrated ownership, a thin managerial labour market, and reliance on internal capital allocation — this pattern is consistent with conservative reactions in which managers prefer to retreat from costly unrelated diversification rather than expand it under volatility (Khanna & Palepu, 2000).

The direct effects of diversification on bankruptcy risk support both H7 and H8. RDIV is positively associated with bankruptcy risk, whereas UDIV is negatively associated with it. This finding closely matches the recent evidence of Vu and Ngo (2025), who report that related diversification significantly increases expected default frequency, while current unrelated diversification reduces it in an emerging-market context. The result also helps reconcile competing views in the recent diversification literature. On the one hand, diversification can amplify bankruptcy risk under severe shocks because of higher cash-flow volatility and tighter financing constraints. On the other hand, diversification may improve resilience when firms can use internal capital and labour markets effectively (Wang, 2023; Chen & Nguyen, 2025). The present findings suggest that both views can hold, but for different diversification forms: in this sample, related diversification appears to preserve correlated exposures and is therefore associated with higher bankruptcy risk, whereas unrelated diversification offers stronger risk-spreading benefits, consistent with Portfolio Theory. Overall, the H7/H8 pattern is best characterised as evidence of asymmetric associations: related diversification is associated with higher bankruptcy risk, whereas unrelated diversification is associated with lower bankruptcy risk, consistent with the outcome-filter logic of portfolio theory in our integrated framework.

Table 12. Results of indirect effects

Hypothesis	Path	Original sample	Sample mean	t-statistics	p-values	2.5%	97.5%	Decision
H9a	GV → RDIV → Bankruptcy	0.039	0.042	1.99	0.047	0.021	0.076	Supported
H9b	L_GV → RDIV → Bankruptcy	0.019	0.028	1.38	0.168	-0.056	0.166	Not supported
H10a	GV → UDIV → Bankruptcy	-0.007	-0.011	1.01	0.312	-0.184	0.098	Not supported
H10b	L_GV → UDIV → Bankruptcy	0.026	0.032	1.49	0.137	-0.096	0.059	Not supported

Note. GV = growth volatility; L_GV = lagged growth volatility; RDIV = related diversification; UDIV = unrelated diversification; Bankruptcy = bankruptcy risk.

Mediating roles of business diversification

The mediation tests reported here follow a four-step procedure consistent with Hair et al. (2022) and Zhao et al. (2010). Step 1: bootstrap the structural model with 10,000 resamples and bias-corrected and accelerated (BCa) 95% confidence intervals to obtain the sampling distributions of all path coefficients. Step 2: compute each indirect effect as the product of its constituent direct paths (e.g., for H9a, β_GV→RDIV × β_RDIV→Bankruptcy) and assess significance by checking whether the bootstrap CI excludes zero. Step 3: classify each significant indirect effect as full or partial mediation by comparing it with the corresponding direct effect (Zhao et al., 2010). Step 4: report the variance accounted for (VAF) for each significant mediation pathway, where VAF = indirect / (indirect + direct), to express the proportion of the total effect that operates through the mediator. This procedure allows simultaneous evaluation of competing parallel mediators (RDIV and UDIV) within a single bootstrap framework, which is one of the methodological advantages of PLS-SEM over sequential regression-based mediation tests.

Table 12 presents the specific indirect effects of GV and L_GV on bankruptcy risk through RDIV and UDIV. The mediation results provide partial support for the indirect-effect hypotheses. Specifically, the significant indirect effect from current growth volatility (GV) to bankruptcy risk through related diversification (RDIV) supports H9a, whereas the indirect effect through unrelated diversification (UDIV) is not significant; thus, H10a is not supported. In addition, neither of the lagged indirect effects is statistically significant, meaning that H9b and H10b are not supported. These findings indicate that RDIV is not merely a parallel strategic response to current volatility, but a channel through which current growth volatility is associated with higher bankruptcy risk. By contrast, although UDIV is associated with lower bankruptcy risk elsewhere in the model, it does not appear to operate as an immediate mediating channel from current volatility to bankruptcy risk. This pattern is consistent with recent evidence from an emerging-market setting showing that related diversification heightens expected default frequency, whereas current unrelated diversification reduces it (Vu & Ngo, 2025).

From a theoretical perspective, the support for H9a is consistent with the study's integrated framework. Signaling theory suggests that current growth volatility is consistent with a salient risk-signal interpretation to managers and investors. Complementing this, Upper Echelons Theory helps explain how the cognitive bases and experiential filters of top managers shape the strategic response to that signal. Under such conditions, the theory of economies of scope provides a plausible explanation for why firms may respond through related diversification, which is more feasible and operationally familiar than unrelated expansion. However, once firms diversify into related activities, their exposure may remain concentrated in businesses subject to similar shocks, thereby being associated with higher bankruptcy risk. This risk-amplifying mediation pathway may be more pronounced in emerging markets than in developed economies. In developed markets, deeper capital markets, stronger legal institutions, and greater access to external financing allow firms to absorb volatility through financial hedging and capital reallocation rather than through operational diversification (Singhal & Zhu, 2013). In contrast, emerging-market firms with limited access to external capital may rely more heavily on operational diversification as a substitute, making the choice between related and unrelated diversification a more consequential determinant of bankruptcy risk. By contrast, the non-significant indirect effect through UDIV implies that portfolio theory is more relevant for explaining the longer-run risk-spreading potential of unrelated diversification than its use as an immediate reaction to current volatility.

The non-significant results for H9b and H10b further clarify the temporal structure of the model. Although lagged growth volatility influences later diversification choices (H4, H6), these delayed strategic responses do not significantly carry over into current bankruptcy risk through the mediation channels specified here. Statistically, this outcome is consistent with the relatively modest magnitudes of the individual constituent paths: when both direct paths in a mediation chain are significant but small in absolute terms, their product can yield an indirect effect whose bootstrap confidence interval crosses zero, even though neither constituent path is negligible on its own (Hair et al., 2022). Substantively, this suggests that the bankruptcy-risk transmission mechanism is primarily contemporaneous, while the influence of past volatility is more visible in subsequent strategic repositioning than in a statistically detectable indirect effect on current default risk. The three null pathways can be read more precisely as follows. For H9b (L_GV → RDIV → Bankruptcy), the direct L_GV → RDIV path is significant, but the indirect effect on bankruptcy risk is not: this pattern suggests that the risk-relevant signalling content of volatility decays over time, so that the related-diversification response to past volatility no longer carries the same immediate bankruptcy-risk implication as the response to current volatility. For H10a (GV → UDIV → Bankruptcy), the indirect effect is non-significant primarily because its first constituent path - the current GV → UDIV link (H5) - is itself non-significant; a mediation pathway cannot transmit an effect through a link that does not exist, so the null result for H10a is a direct and internally consistent consequence of the null result for H5 rather than an independent finding. For H10b (L_GV → UDIV → Bankruptcy), although the L_GV → UDIV path is significant and negative, the onward UDIV →

Table 13. Robustness check - Alternative proxy for bankruptcy risk

Effects	Original sample	Sample mean	P values	2.5%	97.5%
Direct effects					
GV -> Z-score_inverse	0.131	0.135	0.021	0.104	0.224
GV -> RDIV	0.232	0.211	0.024	0.122	0.402
GV -> UDIV	0.042	0.052	0.341	-0.122	0.199
L_GV -> RDIV	0.147	0.151	0.037	0.045	0.274
L_GV -> UDIV	-0.147	-0.151	0.052	-0.212	0.042
L_GV -> Z-score_inverse	0.046	0.037	0.113	-0.104	0.172
RDIV -> Z-score_inverse	0.168	0.172	0.037	0.122	0.269
UDIV -> Z-score_inverse	-0.142	-0.151	0.044	-0.277	-0.092

Bankruptcy effect does not accumulate into a significant indirect effect, consistent with unrelated diversification operating as a slower-moving, structural risk-reduction mechanism whose benefits are not fully realised within the one-period lag structure of the model. Taken together, these null mediation results reinforce the central finding that it is the related-diversification response to current volatility - not the lagged or the unrelated pathways - that constitutes the salient risk-amplifying channel in the Vietnamese setting.

These findings are especially relevant in the Vietnamese context. As noted earlier, Vietnam is a rapidly developing emerging market with a young capital market and limited restructuring infrastructure, conditions under which firm-level instability can have more severe financial consequences. Recent evidence also shows that distress risk in emerging markets is shaped not only by firm-level conditions but also by institutional context and broader external financial pressures (Asis et al., 2021; Zouaghi et al., 2024). In such an environment, the risk-amplifying pattern associated with RDIV may be stronger because related businesses remain exposed to similar local shocks, whereas the risk-reducing pattern associated with UDIV may be more valuable because internal capital allocation across diverse businesses can partly substitute for underdeveloped external financing channels (Vu & Ngo, 2025). From a broader sustainability perspective, this distinction is important because corporate financial distress can spill over beyond the firm itself to employment, supply chains, and community welfare (Antoniades et al., 2020).

From a sustainable development perspective, the findings suggest, rather than prove, that diversification composition can matter for the broader sustainability agenda; bearing this conditional reading in mind, the implications below should be read as informed conjectures consistent with the data rather than as established policy prescriptions. These findings nonetheless carry direct implications for the broader sustainability agenda. The risk-amplifying pattern associated with related diversification suggests that firms responding to volatility through strategically proximate activities may inadvertently increase their vulnerability, undermining the stable corporate base necessary for achieving SDG 8 (Decent Work and Economic Growth). When firms fail, the negative externalities extend to employment, supply chains, and community welfare (Zambrano Farias et al., 2021; Song & Zhao, 2024), directly hindering progress toward SDG 9 (Industry, Innovation, and Infrastructure). Conversely, unrelated diversification appears to be associated with stronger corporate financial resilience by distributing risk across uncorrelated activities, suggesting that diversification composition, not merely its level, is a key determinant of whether firms contribute to or detract from sustainable economic development. These results underscore the importance of integrating corporate financial sustainability considerations into both firm-level strategy and policy frameworks aimed at fostering resilient business ecosystems in emerging economies.

Robustness Check

To assess the robustness of the findings, we complement the baseline EDF-based model with two additional checks. First, we replace the dependent variable with an alternative accounting-based proxy for bankruptcy risk. Second, following Sarstedt et al. (2020), we conduct PLS-SEM robustness checks covering endogeneity, unobserved heterogeneity, and nonlinear effects.

Alternative dependent variable

As an alternative proxy for bankruptcy risk, we use the Altman Z-score. Because a higher Z-score indicates lower financial distress, we transform it into an inverse normalized indicator so that it moves in the same direction as the EDF:

$$Z_{\text{inverse}} = \frac{Z_{max} - Z_i}{Z_{max} - Z_{min}}$$

Thus, a higher value of Z-score_inverse indicates greater financial distress.

Table 13 shows that the results are largely consistent with the baseline findings. GV remains positively associated with bankruptcy risk (β = 0.131, p = 0.021), GV and L_GV remain positively associated with RDIV (β = 0.232, p = 0.024; β = 0.147, p = 0.037), RDIV remains positively associated with bankruptcy risk (β = 0.168, p = 0.037), and UDIV remains negatively associated with bankruptcy risk (β = -0.142, p = 0.044). In addition, GV → UDIV remains insignificant (β = 0.042, p = 0.341), and L_GV → Z-score_inverse also remains insignificant (β = 0.046, p = 0.113). The only notable difference is that the path L_GV → UDIV becomes marginally insignificant at the 5% level (β = -0.147, p = 0.052). Overall, the alternative specification supports the stability of the baseline conclusions.

Robustness check in PLS-SEM framework

Following Sarstedt et al. (2020), we further assess the robustness of the PLS-SEM results by examining endogeneity, unobserved heterogeneity, and nonlinear effects.

(i) Endogeneity

Following Hult et al. (2018), we apply the Gaussian copula approach after confirming that the relevant latent variable scores are nonnormally distributed. The results in **Figure 4** show that none of the Gaussian copula terms is statistically

Table 14. FIMIX: Fit indices for the one- to five-segment solutions

Criteria	Segments				
	1	2	3	4	5
AIC (Akaike's information criterion)	2088.41	2081.37	2067.21	2061.23	2044.31
AIC3 (modified AIC with Factor 3)	2099.38	2104.81	2102.24	2108.41	2103.28
AIC4 (modified AIC with Factor 4)	**2110.48**	2127.86	2137.18	2155.43	2162.38
BIC (Bayesian information criterion)	2124.36	2156.78	2181.19	2214.53	2236.58
CAIC (consistent AIC)	**2135.31**	2179.79	2216.39	2261.23	2295.25
HQ (Hannan-Quinn criterion)	2102.99	2112.22	2113.45	2123.41	2122.22
MDL5 (minimum description length with factor 5)	2355.64	2640.48	2917.34	3202.94	3477.35
LnL (LogLikelihood)	-1033.24	-1017.94	-998.64	-983.71	-963.19
EN (normed entropy statistic)	0	0.42	0.60	0.64	0.76
NFI (non-fuzzy index)	0	0.47	0.58	0.59	0.70
NEC (normalized entropy criterion)	0	112.05	77.75	69.85	46.10

significant, indicating that endogeneity is unlikely to bias the structural model estimates.

Because the relationship between diversification and bankruptcy risk may be simultaneous, endogeneity is a material concern in this setting: firms close to distress may alter their diversification strategy, while diversification may in turn affect distress risk. More specifically, four sources of endogeneity may bias the structural estimates in this context: (i) reverse causality (firms close to distress may alter diversification choices); (ii) omitted variable bias (unobserved firm characteristics affecting both diversification and bankruptcy risk); (iii) measurement error in the proxy variables used to operationalise the constructs; and (iv) simultaneity (concurrent decisions). The demeaning procedure (Section *Panel data in an SEM model*) addresses (ii) for time-invariant unobserved heterogeneity, while the Gaussian copula tests reported below target the residual concerns related to (i), (iii), and (iv).For completeness, we provide additional details on the Gaussian copula procedure. The approach of Park and Gupta (2012) addresses endogeneity without instrumental variables by jointly modelling the distribution of a potentially endogenous regressor and the structural error using a Gaussian copula. In implementation, for each potentially endogenous variable X (here GV, L_GV, RDIV, and UDIV), we compute the copula term $X^c = \Phi^{-1}(F(X))$, where F(X) is the empirical cumulative distribution function of X and Φ^{-1} is the inverse of the standard-normal CDF, and include this copula term as an additional regressor in the structural equation. The coefficient on the copula term then provides a direct test of endogeneity: a coefficient indistinguishable from zero indicates that endogeneity is unlikely to bias the structural estimates (Becker et al., 2022).

The Gaussian copula approach requires non-normal distribution of the endogenous regressor (Park & Gupta, 2012). We confirmed this prerequisite using Cramér–von Mises and Kolmogorov–Smirnov tests on the latent variable scores of GV, L_GV, RDIV, and UDIV; all four reject the null of normality at conventional levels, satisfying the identification condition.

A second concern raised by simultaneity is the possibility of reverse causality: firms close to financial distress may pursue diversification (Lang & Stulz, 1994; Volkov & Smith, 2015), so the link from RDIV/UDIV to bankruptcy risk could partly reflect distress-driven diversification choices rather than diversification-induced risk effects. Three features of our research design mitigate this concern. First, the demeaning procedure (Section *Panel data in an SEM model*) eliminates time-invariant unobserved firm heterogeneity, which is the principal source of cross-sectional reverse causality. Second, lagged growth volatility (L_GV) is by construction predetermined relative to current diversification choices, so the L_GV → RDIV/UDIV paths are not subject to contemporaneous reverse causality. Third, the Gaussian copula tests reported below directly assess any remaining endogeneity in the diversification–bankruptcy link.

Across all four potentially endogenous variables (GV, L_GV, RDIV, UDIV), the Gaussian copula terms are statistically insignificant at conventional levels (all $p > 0.10$), as shown in **Figure 4**. Taken together with the demeaning procedure and the predetermined nature of L_GV, this evidence indicates that the structural estimates are unlikely to be materially biased by endogeneity, although we acknowledge in Section *Limitations and Future Research* that complete causal identification would require external instruments or exogenous shocks. We emphasise that this result does not prove the absence of all endogeneity; rather, it provides evidence that residual endogeneity is unlikely to materially drive the reported path estimates, so the structural results are best read as robustness-supported associations rather than definitive causal effects.

(ii) Unobserved heterogeneity

To assess unobserved heterogeneity, we use the FIMIX-PLS procedure. The fit indices reported in **Table 14** show that the conservative criteria consistently support a one-segment solution. Consistent with Sarstedt et al. (2011), the joint evidence from AIC3 and CAIC also points to a one-segment model. These results suggest that substantial unobserved heterogeneity is not present in the sample. To ensure transparency in segment-number selection, we report the full set of information criteria — AIC, AIC3, AIC4, BIC, CAIC, MDL5, EN, NEC, and NFI — for one- to five-segment solutions in **Table 14**. Following Sarstedt et al. (2011), we rely primarily on the more conservative AIC3 and CAIC criteria, which consistently support a one-segment solution; this convergence across criteria reduces the risk that the no-heterogeneity conclusion is sensitive to a single criterion choice.

(iii) Non-linear effect

To test for possible nonlinear relationships, we include quadratic terms following Svensson et al. (2018) and Sarstedt et al. (2020). As shown in **Table 15**, none of the quadratic effects is statistically significant. This finding indicates that

Table 15. Quadratic effects

Quadratic Relationship	Coefficients	P-value	Confidence interval	
			2.5%	*97.5%*
GV*GV → RDIV	0.012	0.717	-0.084	0.112
GV*GV → UDIV	0.061	0.139	-0.101	0.123
L_GV*L_GV → RDIV	0.052	0.214	-0.132	0.154
L_GV*L_GV → UDIV	0.062	0.136	-0.106	0.148
GV*GV → Bankruptcy	0.044	0.276	-0.115	0.125
L_GV*L_GV → Bankruptcy	0.056	0.201	-0.166	0.092
RDIV*RDIV→ Bankruptcy	0.027	0.411	-0.099	0.082
UDIV*UDIV →Bankruptcy	0.018	0.684	-0.075	0.087

the linear specification is appropriate and that the main results are robust to potential nonlinearities.

Taken together, the alternative dependent variable analysis and the PLS-SEM robustness checks provide additional support for the stability of the main findings.

CONCLUSION AND IMPLICATIONS

Conclusion

This study examines the relationships among growth volatility, diversification strategies, and bankruptcy risk in a sample of 485 non-financial Vietnamese listed firms over the period 2013–2024. Using PLS-SEM with a multidimensional measure of growth volatility, the study finds that current growth volatility is positively associated with bankruptcy risk directly. It is also positively associated with related diversification, which in turn is associated with higher bankruptcy risk, indicating a significant risk-amplifying indirect pathway consistent with the integrated analytical framework. By contrast, unrelated diversification is negatively associated with bankruptcy risk, although current growth volatility does not significantly affect unrelated diversification. In addition, lagged growth volatility is associated with both related and unrelated diversification, but it is not directly associated with current bankruptcy risk. Overall, the findings indicate that the bankruptcy-risk patterns associated with growth volatility depend not only on its timing but also on the type of diversification strategy adopted by firms. These results have direct implications for sustainable development: by showing that diversification composition is associated with corporate financial sustainability, the study contributes to understanding the micro-level mechanisms through which firm-level instability can undermine the conditions necessary for SDG 8 and SDG 9 attainment in emerging economies.

Beyond these empirical findings, the study makes three theoretical contributions. First, it integrates signaling theory, Upper Echelons Theory (Hambrick & Mason, 1984), the theory of economies of scope, and portfolio theory into a unified analytical chain (trigger → choice → outcome filter), generating predictions about the asymmetric mediation of bankruptcy risk that no single theory can produce alone. Second, it provides empirical evidence of asymmetric mediation in an emerging-market context, suggesting that diversification composition rather than diversification level is the relevant dimension for firm-level financial resilience. Third, by operationalising growth volatility as a multidimensional formative composite extending Coad et al. (2017), it offers a measurement template that future studies can apply to other emerging markets. From a sustainable development perspective, the findings contribute to the micro-foundations of SDG 8 (decent work and economic growth) and SDG 9 (industry, innovation, and infrastructure) attainment in emerging economies: corporate financial resilience appears to depend not only on the level of diversification but on its composition, and policy support for managerial capability development — particularly the capacity to execute risk-spreading unrelated diversification — may therefore play an under-appreciated role in advancing the firm-level foundations of inclusive economic development (Khanna & Palepu, 2000).

Managerial and Policy Implications

The findings offer several practical implications for managers. First, growth volatility should be monitored as an early warning signal of financial vulnerability. Tracking instability in sales, assets, employment, and operating profits may help managers identify rising bankruptcy risk at an early stage. Second, managers should be cautious when responding to volatility through related diversification. Although related diversification may provide operational synergies, the results indicate that it is associated with higher bankruptcy risk. Third, unrelated diversification appears to reduce bankruptcy risk and may therefore serve as a useful risk-spreading strategy, particularly in volatile environments. Overall, the findings suggest that managers should evaluate diversification choices not only in terms of strategic fit and operational efficiency but also in terms of their implications for bankruptcy risk and long-term financial resilience. For policymakers, these results highlight the importance of fostering institutional conditions, such as accessible capital markets, transparent corporate governance frameworks, and effective insolvency regimes, that enable firms to pursue risk-reducing diversification strategies, thereby strengthening the corporate financial sustainability that underpins broader economic development goals. These broad principles translate into three concrete actions. Concretely, the early-warning function above can be operationalised through a simple internal dashboard that tracks year-over-year volatility in the four growth dimensions (sales, assets, employment, and operating profit) and flags a firm for closer review when volatility in two or more dimensions exceeds its own three-year historical average by a pre-set threshold. In addition, when a firm does expand through related diversification during a period of elevated volatility, the associated concentration of correlated cash flows implies that the firm

should simultaneously strengthen its liquidity buffer (for example, by raising precautionary cash holdings or securing committed credit lines) to offset the reduced coinsurance benefit — related diversification and financial slack should be managed as complements rather than substitutes. Furthermore, because unrelated diversification is associated with lower bankruptcy risk but is difficult to execute quickly, firms that anticipate persistent volatility should invest ahead of time in the managerial and organisational capabilities (cross-industry expertise, decentralised decision structures, and acquisition-integration experience) needed to make unrelated diversification a viable option when it is required. Finally, for policymakers and market regulators in emerging economies, the results point to concrete levers: supporting managerial-capability development programmes for listed firms, deepening capital markets so that unrelated diversification is financially feasible, and strengthening insolvency and restructuring regimes so that the downside of firm-level volatility is contained before it cascades into the broader economy.

Limitations and Future Research

This study has several limitations. The sample is limited to non-financial Vietnamese listed firms, which may constrain the generalizability of the findings. In addition, bankruptcy risk is primarily proxied by the KMV-Merton EDF. Future research may extend this framework to other emerging markets and broader dynamic settings.

A second limitation concerns causal interpretation. Although our analysis incorporates fixed-effect demeaning, Gaussian copula endogeneity tests, and additional PLS-SEM robustness checks across endogeneity, unobserved heterogeneity, and non-linearity, PLS-SEM provides relatively weaker tools for full causal identification compared with instrumental variables or natural experiments. The findings should therefore be interpreted as conditional associations consistent with the proposed integrated framework rather than as definitive causal effects, and we frame our contributions in terms of patterns of association robust to multiple specification choices. Future research could exploit exogenous shocks (e.g., regulatory changes, trade liberalization episodes, or industry-specific tariff revisions) to provide stronger causal identification of the diversification–bankruptcy nexus, and could examine moderating roles of corporate governance, ownership structure, and macroeconomic conditions that lie beyond the scope of the present analysis. Relatedly, a third limitation concerns the treatment of control variables. While the demeaning procedure removes all time-invariant firm characteristics and year dummies absorb common shocks, this design-based strategy does not control for time-varying firm-specific factors that may independently affect bankruptcy risk - most notably year-over-year changes in leverage, firm size, profitability, and liquidity. To the extent that such factors are correlated with both growth volatility and diversification choices, they could contribute to the estimated associations; the present design mitigates but does not fully eliminate this possibility. We therefore state explicitly that our estimates should be read as associations net of time-invariant heterogeneity and common shocks, but not necessarily net of all time-varying confounders. Future research incorporating explicit time-varying controls for leverage, size, profitability, and liquidity - or employing dynamic panel estimators designed to accommodate such controls alongside the mediation structure - would provide a valuable robustness extension to the present findings.

Author contributions: VHT: conceptualization, methodology, data curation, formal analysis, writing – original draft, writing – review & editing; **NTT:** validation, writing – review & editing, supervision. Both authors agreed with the results and conclusions.

Funding: This research is funded by the Ministry of Education and Training, Vietnam, under grant number B2024-MBS-08.

Ethical statement: The authors stated that the study does not require approval from an ethics committee since it uses publicly available secondary data from Vietnam's stock exchanges.

AI statement: The authors stated that no artificial intelligence tools were used in the data analysis or interpretation of results. AI-assisted tools were used solely for language editing and grammar checking. The authors take full responsibility for the content of this manuscript.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: The data that support the findings of this study are available from Vietnam's stock exchanges (HOSE and HNX) through financial databases. Data are available from the corresponding author upon reasonable request.

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