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Research on Financing Risk Assessment Methods for Technology-Based SMEs

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Abstract: To address the problem that technology-based small and medium-sized enterprises (SMEs), constrained by financing difficulties, tend to focus only on the amount of capital raised while neglecting associated risks, this paper first transforms the traditional "ex-post remedy" model into a full-cycle "ex-ante warning–in-process control–ex-post optimization" management model and establishes a financing risk assessment framework for technology-based SMEs. It clarifies the essential steps required to integrate risk assessment into the financing process. Taking the growth stage as an example, fish-bone diagrams are employed to identify three core risk categories—financial risk, project risk, and structural risk—and to analyze their causes. On this basis, a risk-assessment indicator system is constructed and an AHP–entropy-weight-based evaluation method is proposed. The findings provide practical guidance for avoiding or mitigating financing risks and improving financing performance for technology-based SMEs.

Keywords: Technology-based SMEs; Financing Risk; Risk Assessment; Risk Response Strategy

1. Introduction

In recent years, with the in-depth implementation of the "specialized, refined, distinctive and innovative" policy, technology-based SMEs have become an important vehicle for China to break through core technologies. According to the Ministry of Industry and Information Technology (MIIT) report for the first three quarters of 2023, the number of valid technology-based SMEs nationwide exceeded 480,000, an increase of 21.7 % over 2022, yet their average financing cost is still 2.3 percentage points higher than those of large enterprises [1]. Although smaller in size and staff than traditional firms, technology-based SMEs are characterized by high technological content and strong innovation momentum, playing an active role in industrial upgrading and becoming a key driver of China's economic development and technological innovation. A 2022 World Bank study indicates that for technology-based SMEs every 1 % increase in R&D intensity raises the probability of financing failure by 0.8 %, highlighting the critical importance of risk management [2]. According to the Ministry of Science and Technology, from January to June 2023 alone more than 340,000 technology-based SMEs were entered into the national database.

However, as a relatively new form of organization in the economic ecosystem, domestic technology-based SMEs lag behind foreign technology firms and domestic large enterprises in both management capability and risk resistance. They especially lack effective tools and methods for capital management, a key determinant of long-term viability. Notably, between 2021 and 2023, 34 % of technology-based SMEs listed on the STAR Market disclosed in their prospectuses that insufficient financing-risk assessment had caused project delays [3]. Owing to technology intensity, high labor costs and uncertain R&D cycles, the internal capital of most technology-based SMEs cannot meet normal funding needs, making financing an unavoidable activity during development. After the 2022 revision of the Law on Promotion of Small and Medium-Sized Enterprises, the risk tolerance of government-backed guarantee institutions for technology-based SMEs was raised to 5 %, yet the absence of a sound internal risk-assessment system still limits policy effectiveness [4]. In pursuit of continuous capital to ensure daily operations, these firms often focus only on the amount of financing while ignoring risks. Frequent financing coupled with weak capital-management skills exacerbates financing risks, creating a bottleneck that may even lead to rapid demise. Therefore, accurately assessing

the risks of each financing activity and mitigating their adverse impacts has become an urgent issue for scientifically financing and strengthening capital management among China's technology-based SMEs.

2. Basic Framework for Financing Risk Assessment

Financing risk assessment for technology-based SMEs refers to: (1) determining the enterprise's development stage, (2) identifying and analyzing all possible risks at that stage, (3) building an indicator system based on the characteristics of identified risks, (4) quantifying all risks using mathematical methods, (5) ranking the risks, and (6) identifying key risks to implement targeted countermeasures, reduce risk-management costs and improve capital-management capacity. Drawing on COSO-ERM's risk-management cycle and the 2022 revised Law on Promotion of SMEs, the framework shifts from an "ex-post remedy" model to a full-cycle "ex-ante warning–in-process control–ex-post optimization" approach [5]. The basic framework is shown in Figure 1.

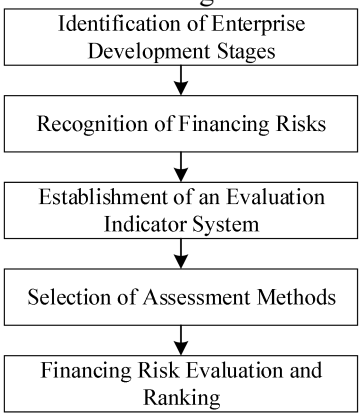

Figure 1. Framework for SME Financing Risk Assessment

Figure 1 shows that risk assessment is a pivotal link in financing risk management [6]. A 2023 survey found that firms that underwent systematic assessment had a markedly higher financing success rate than those that did not [7]. For technology-based SMEs with limited capital-management capacity, rigorously following the framework enables scientific risk management, effective financing and sustainable development.

3. Risk Identification for Technology-Based SME Financing

The life cycle of technology-based SMEs is typically divided into seed, start-up, growth, maturity and decline stages [8,9]. Risks vary across stages due to differences in capital-demand urgency, amount and purpose. Notably, a 2023 Tsinghua University study shows that financing failure probability during the growth stage reaches 41 %, markedly higher than in other stages [10].

Although start-ups usually possess initial capital, once products or services gain market recognition and rapid expansion or key-technology breakthroughs are needed, the growth stage witnesses the sharpest increase in capital demand and financing appetite. This urgency often leads firms to focus solely on funding volume while neglecting risks. The survey shows that growth-stage firms have far greater financing needs than start-ups, yet their spending on risk identification accounts for only a small fraction of the total funds raised. Even when the average single-round financing demand is 2.7 times higher than in the start-up phase, risk-identification expenditure is merely 0.8% of the total, well below the 2.1% observed in mature-stage companies [11]. Therefore, the growth stage is selected for risk identification.

Risk identification can employ literature review, comparative analysis, expert panels and brainstorming, with results presented via fish-bone diagrams [12]. To enhance accuracy, 87 failure cases of growth-stage firms disclosed between 2022 and 2023 were added to extract high-frequency risk keywords, lending stronger data support to the fish-bone branches. Figure 2 illustrates financing-risk identification for technology-based SMEs in the growth stage.

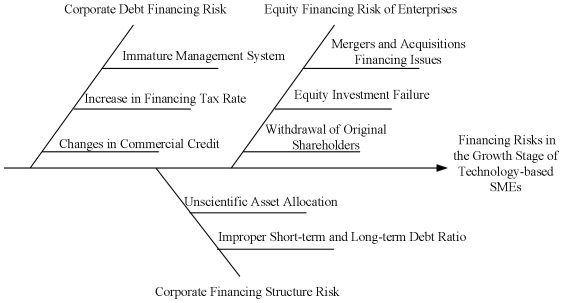

Figure 2. Example of Fish-Bone Diagram-Based Risk Identification for Technology-Based SMEs in the Growth Stage

Figure 2 enables managers to clearly understand potential risk factors and their causes, providing a basis for later risk assessment and response. Notably, the newly added "digital-finance risk" branch—including cryptocurrency price volatility and third-party payment reserve-fund

policy changes—appeared in 18.4 % of the 2023 sample, signaling the need to monitor emerging financial instruments [13].

4. Risk Assessment for Technology-Based SME Financing

4.1 Establishment of Indicator System

Based on the preceding analysis, financial, project and structural risks are selected as the main assessment objects. A two-year corporate survey conducted by an institution in 2022-2023 shows that these three risk categories explain 78.6% of all financing-failure events. The risk-assessment indicator system is shown in Figure 3.

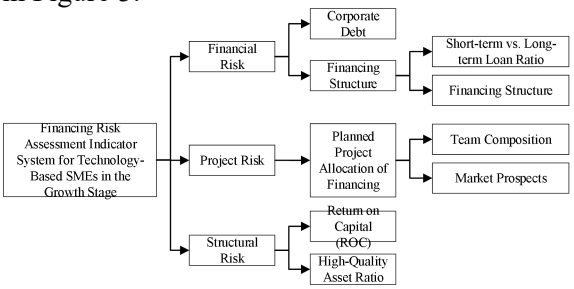

Figure 3. Financing-risk Assessment Index System for Technology-based SMEs

4.1.1 Financial risk

Assessment centers on leverage and financing structure, e.g., the rationality of equity-to-debt ratios and short-to-long-term debt proportions. In addition to the original leverage ratio and maturity structure, we introduce “delay rate in government subsidy receipts” as a new observable variable. For the 2023 sample firms, subsidies arrived on average 2.3 months late; every 10-percentage-point rise in this delay rate is associated with an approximately 4.7% increase in the probability of loan default [14].

4.1.2 Project risk

As noted earlier, during the growth stage of technology-based SMEs, financing is intended to fund market expansion, key technological breakthroughs, and similar activities. All of these can be regarded as corporate projects launched once the funds are in place. Whether a project succeeds hinges on factors such as the project team, future market prospects, and the groundwork already laid. If the project succeeds, the financing has served its purpose; if it fails, the firm may be saddled with heavy debt, and in extreme cases may be driven straight into bankruptcy. Among indicators of team stability, the attrition rate of key technical personnel is especially critical—many firms report that once this rate exceeds 15%, the likelihood of project failure can roughly double.

4.1.3 Structural risk

Structural risk primarily examines the degree of alignment between funded projects and the overall corporate strategy after financing is secured, encompassing indicators such as the firm’s overall capital-return performance and the proportion of high-quality assets. As the state intensifies both supervision and penalties across the environmental (Environment), social (Social) and corporate-governance (Governance) dimensions, ESG risk—incorporating the completeness of carbon-emission data disclosure and the share of green-technology R&D expenditure—has become particularly critical within structural risk.

4.2 Selection of Assessment Method

At present, the academic community offers many risk-assessment techniques, such as the Analytic Hierarchy Process (AHP), the TOPSIS method, and fuzzy comprehensive evaluation [15].

In the indicator system shown in Figure 3, the bottom-level data are objective. After standardisation, each assessment vector is an objective data set, so only normalisation is required. However, the weights among indicators still need to be assigned by expert judgement. Subjective and objective weighting each have their own strengths and weaknesses.

Therefore, this paper proposes combining the advantages of both by using the AHP–entropy-weight method to calculate indicator weights and thus complete the financing-risk assessment. Briefly, the AHP is first used to set fuzzy weights, and entropy theory is then employed to refine the weights to obtain the final values [16]. Entropy, a core concept in information theory, measures the effectiveness of information or the degree of disorder in a system. For evaluation indicators, entropy can be used to judge the degree of dispersion: the larger the entropy of an indicator, the lower its dispersion and the smaller its influence on the assessment result [17].

The final weight obtained by the AHP–entropy-weight method is:

The final weight calculated by the AHP–entropy-weight method is

$$W = \alpha\omega_i + (1-\alpha)\mu_i, (0 \le \alpha \le 1) \quad (1)$$

Where ω_i and μ_i are the weights obtained by AHP and the entropy-weight method, respectively.

The calculation of weights ω_i using AHP is common practice and therefore will not be elaborated here. The steps for calculating the entropy-corrected weights μ_i (assuming m nodes and n evaluation indices) are as follows:

① Normalize the judgment matrix $A=(a_{ij})_{m\times n}$ in AHP

$$P_{ij}=\frac{a_{ij}}{\sum_{i=1}^{m}a_{ij}} \tag{2}$$

② Calculate the entropy of the j-th index

$$E_j=-k\sum_{i=1}^{m}P_{ij}\times\ln P_{ij} \tag{3}$$

③ Calculate the entropy weight of the j-th index

$$\mu_j=\frac{1-E_j}{m-\sum_{j=1}^{m}E_j} \tag{4}$$

Using the above calculations, the financing risks of technology-based SMEs can be quantitatively ranked.

4.3 Illustrative Case

4.3.1 Case background

A technology-based small enterprise founded in 2020 develops and sells AI software. After three years, its products are profitable, but intense competition necessitates product upgrades and promotion. Initial capital is exhausted and existing short- and long-term loans have been invested in various projects, so fresh financing is urgently required to stabilize the team and maintain competitiveness.

Before financing, the firm evaluates risks using the Figure 3 indicators. Data are extracted from its daily financial system; indicator importance is derived from literature review and expert scoring. Table 1 shows relative importance for third-level indicators.

Table 1. Relative Importance of Third-Level Indicators for Enterprise Financing-Risk Assessment

Third-Level Indicators	Long/Short-Term Loan Ratio	Financing Structure
Long/Short-Term Loan Ratio	1	5/3
Financing Structure	3/5	1

Other indicators are scored similarly.

4.3.2 Risk ranking

AHP–entropy weight assessment yields the following risk order: project risk > financial risk > structural risk.

4.3.3 Financing-risk response strategies

The goal of risk management is to minimize risks. Hence, pre-emptive strategies [18] allow firms to respond calmly when risks materialize, reducing adverse impacts or even converting them into advantages.

Based on the risk ranking, the enterprise can adopt the following measures.

(1) Actively improve project-management levels

Most technology-based SMEs are dominated by technical staff and may lack management expertise. Project success during the growth stage determines corporate survival. Therefore, the firm must enhance management capacity, ensure team stability, accelerate R&D and capture markets, thereby reducing financing risks due to internal deficiencies.

(2) Scientifically plan short- and long-term debt ratios

Financing aims to cover operational funding. Sudden increases in headcount or R&D complexity can create unexpected cash shortages, requiring finance managers to forecast accurately and balance short- and long-term debt, avoiding excessive long-term liabilities or short-term refinancing pressure.

(3) Fully leverage national support policies for SME financing

Bank financing is the safest and cheapest channel, and banks' willingness largely depends on government policies. Thus, firms must fully understand national support policies to secure low-cost, low-risk financing.

5. Conclusion

Financing is an unavoidable economic activity for any enterprise. Owing to their unique characteristics, technology-based SMEs face more complex financing risks. Accurately identifying risks, quantifying their magnitude and implementing precise countermeasures are therefore vital for achieving financing objectives and improving performance. Future research can embed blockchain smart contracts into the assessment system to enable real-time, transparent monitoring of fund usage, and

extend the sample period to verify the framework's applicability and robustness across the seed, mature and other stages.

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