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From Banks or Venture Capitals? The Financing Choices of Chinese High-Tech Enterprises During the Start-Up Period

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Abstract

The purpose of this research is financing options for high-tech enterprises in China during their early-stage. This study develops a three-phase model to analyze the financing choices of Chinese high-tech firms between banking and venture capital while considering information asymmetry. The findings reveal that opaque information disclosure favors venture capital financing, while transparent disclosure leads to bank loans for equally qualified high-tech enterprises. Data analysis further confirms that both bank loans and venture capital are viable options for early-stage Chinese high-tech enterprises. These findings offer valuable guidance for high-tech firms and investors navigating China's financial landscape. Moreover, policy management departments can leverage these insights to make informed decisions and facilitate the financing of high-tech enterprises.

JEL Classification: C70, C23, D22, G24.

Plain language summary

The purpose of this research is financing options for high-tech enterprises in China during their early-stage. This study develops a three-phase model to analyze the financing choices of Chinese high-tech firms between banking and venture capital while considering information asymmetry. The findings reveal that opaque information disclosure favors venture capital financing, while transparent disclosure leads to bank loans for equally qualified high-tech enterprises. Data analysis further confirms that both bank loans and venture capital are viable options for early-stage Chinese high-tech enterprises. These findings offer valuable guidance for high-tech firms and investors navigating China's financial landscape. Moreover, policy management departments can leverage these insights to make informed decisions and facilitate the financing of high-tech enterprises. However, there are two limitations. First is the selection of model research objects. The research has chosen bank loans and venture capital as research objects, excluding bonds because of the Chinese government's very high requirements for bond financing for entrepreneurs. The bond financing strategic choices of the entrepreneurs will be studied in the future with the Chinese government lowering the financing requirements. The second is specific enterprise numbers for obtaining successful financing in venture capital and at what stage of enterprise development, which is for future study.

Keywords

high-tech enterprise, venture capital, information asymmetry, bank financing

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Data Availability Statement included at the end of the article

Introduction

In recent years, the Chinese economy has undergone a structural transformation from traditional extensive growth to high-quality comprehensive growth. High-tech companies are required to play a pivotal role in this transformative process (X. Q. Chen & Liu, 2023; Sadykhanova et al., 2019; Y. Xu, 2021). Until the conclusion of 2018, exports from Chinese high-tech enterprises accounted for 31.4% of total manufacturing exports. By the end of 2019, the industry had attained an average workforce of approximately 1.29 million employees, signifying a substantial contribution of high-tech companies to the growth of the Chinese national economy (source: *China Science and Technology Statistical Yearbook 2020*). Financial support for high-tech start-ups is an important factor in their growth (B. Xu et al., 2020). Some theories suggest that a prevailing financing constraint in the high-tech sector may impede economic growth (Guo et al., 2023; Zhang et al., 2021). Given that government policies can assist in financing high-tech enterprises (Dai et al., 2021; Hottenrott & Richstein, 2020). The Chinese government has implemented a series of policies to aim at alleviating financing constraints on high-tech enterprises. These policies encompass initiatives to foster bank loans, such as the "Notice on Strengthening Intellectual Property Pledge Financing and Evaluation Management to Support the Development of Small and Medium-sized Enterprises." Furthermore, substantial endeavors have been undertaken to nurture the domestic venture capital market. Policies like the issuance of the "Interim Measures for the Management of Technology-based Small and Medium-sized Enterprise Venture Investment Guidance Funds" have facilitated venture capital investment. Additionally, the establishment of technology-oriented banks like the SPDB Silicon Valley Bank and the execution of the "Investment-Lending Linkage" policy, which integrates bank loans with venture capital, have contributed to diminishing information asymmetry and facilitating financing services for high-tech enterprises. These measures have played a pivotal role in alleviating the financing challenges confronted by high-tech enterprises in China.

However, the Chinese financial system is still in its developmental phase, and its various markets are not as mature as those in the United States and European countries (Wu & Xu, 2020). Despite the dominance of large banks in the Chinese banking sector, they are unfortunately precluded from engaging in equity financing and assuming management and control of borrowing enterprises, as seen in the United States. The high concentration in the Chinese banking market permits banks to levy elevated interest rates for loans, thus contributing to adverse selection and moral hazard challenges (Bashir et al., 2021). Meanwhile, the extensive control exerted by state-owned banks in China tends to channel the majority of resources and projects toward state-owned enterprises, impacting the allocation of funds and resources within the Chinese economy and rendering access to credit arduous for private and small businesses (Elliott et al., 2014; Qiao et al., 2022). Furthermore, the capital market is far from meeting the financing needs of high-tech enterprises under the current development background of China (Jing et al., 2020). Therefore, the financing challenges faced by Chinese start-up high-tech companies differ from those encountered in developed countries.

Regarding the research on Chinese high-tech enterprises, some scholars have studied the innovation of high-tech enterprises and their contribution to productivity (Q. Li et al., 2021; Shahzad et al., 2023; Shao et al., 2021; D. Wang & Sun, 2022; K. Zhao, 2022). Other scholars have studied the impact of government policies on enterprises financing and financing effectiveness (An & Zhang, 2021; Liu et al., 2023; Z. Zhu & Liao, 2019). However, there is relatively little literature on enterprises from the perspective of financing behavior based on information asymmetry. Therefore, given the prevailing Chinese financing landscape, this study employs signaling theory (Bagella & Becchetti, 1998; Bolton & Freixas, 2000; Ueda, 2004) to formulate a financing model tailored to high-tech enterprises in the start-up stage. The question we'd like to explore is: "Which financing options should early-stage high-tech enterprises have?" This research is financing options for high-tech enterprises in China during their early stages from an enterprise behavior perspective. The study provides a reference for formulating relevant policies to alleviate financing constraints for high-tech enterprises.

This research makes contributions to the literature in the following ways. Firstly, concerning the financial environment in China, the paper contributes by documenting the financing practices of high-tech enterprises within underdeveloped and developing financial markets. Secondly, the study relaxes the assumption in the model that once a bad project succeeds, it will receive much higher returns than the investment, which makes it more in line with practical economic phenomena. Thirdly, we furnish a model that elucidates the mechanism governing the early-stage financing of high-tech enterprises in China, an area that has not received extensive scrutiny.

The remaining portion of the article is organized as follows: Section "Literature Review" furnishes a literature review, while the model's assumptions are outlined in Section "Theoretical Framework and Methodology." The derivation of the model and the optimization procedures are conducted in Section "Optimal Contract Selection." In Section "An Example: Empirical Explanation of the Financing Situation of Chinese High-Tech Enterprises,"

an example is utilized to empirically elucidate the financing landscape of Chinese high-tech enterprises. The conclusion is provided in Section "Conclusions and Discussion," followed by policy recommendations and Section "Policy Suggestions."

Literature Review

There is much literature on the financing of high-tech enterprises. Scholars studied the financing of high-tech enterprises from various perspectives. In summary, there are three following aspects.

Capital Structure and Information Asymmetry

Financing high-tech enterprises presents a complex and challenging scenario within the national economy. This challenge arises from their asset-light nature and limited universality (Carpenter & Petersen, 2002), coupled with the prevalence of asymmetric information (Akerlof, 1978) and heightened uncertainty concerning future development. The presence of information asymmetry substantially impedes these enterprises from attracting external investments (Bergh et al., 2019) and could potentially result in adverse selection (Stiglitz, 2000). Information asymmetry caused by a lack of tangible assets and performance records presents a hurdle for high-tech companies in their pursuit of external capital (Neville & Lucey, 2022).

There are two main viewpoints, one is to support venture capital, and the other is to support bank loans. As Minola et al. (2013), early-stage high-tech firms typically adhere to a revised rendition of the pecking order theory, wherein they exhibit a preference for equity financing over debt financing. Hogan et al. (2017) propose that high-tech companies tend to place greater reliance on external equity capital when confronted with information asymmetry among bank lenders. Owing to their limited or non-existent performance records (Colombo et al., 2023) and the specificity or scarcity of their assets (Carpenter & Petersen, 2002), young high-tech companies encounter challenges in providing sufficient collateral to secure leverage. As a result, venture capital emerges as a more favorable option for them (Bertoni et al., 2015; Croce et al., 2018; Ghazinoory & Hashemi, 2021; Gruin & Knaack, 2020; Ueda, 2004; Y. Wang, 2016).

However, some scholars support bank loans for high-tech enterprises. Coleman and Robb (2012) propose that technology-oriented companies can effectively utilize significant proportions of debt and equity financing in their initial entrepreneurial phases. The proportion of intangible assets among the total assets of high-tech companies serves as a proxy for growth opportunities, indicating that companies with a higher proportion of intangible assets might secure long-term debt to finance their future growth (Cerisola et al., 2012; Degryse et al., 2012). On one hand, a dearth of expertise or divergent interests might lead to diminished funding for risk investments in small technology companies; On the other hand, managers of small and medium-sized enterprises often hold substantial shares. Consequently, they are more inclined toward debt financing, given that it doesn't dilute equity (Huang et al., 2016; Kenourgios et al., 2020; Wellalage & Fernandez, 2019). Furthermore, enterprise digital transformation can augment the capacity of high-tech companies to secure debt financing by diminishing information asymmetry (Sun et al., 2022). This suggests that the utilization of digital technologies and strategies can ameliorate the financial standing of high-tech enterprises, enabling them to access requisite funds.

Capital Structure and Empirical Evidence

A substantial body of empirical research has been dedicated to comprehending the financing dynamics of high-tech companies. On one hand, empirical evidence confirmed the financing methods of venture capital. Mayer (1990) corroborated the relative insignificance of equity as a source of new financing for companies, even within seemingly developed capital markets. Through an analysis of 128 venture capital-supported companies and 233 non-venture capital-supported companies, Bertoni et al. (2015) found that venture capital plays a pivotal role in alleviating financial constraints among portfolio companies. This underscores the affirmative impact of venture capital investments on the financial stability of high-tech companies. L. Zhao et al. (2021) examined how venture capital can mitigate the financial constraints faced by portfolio companies. Expanding upon the role of venture capital, Wu and Xu (2020) empirically investigated the relationship between venture capital backing and bank financing for small and medium-sized enterprises (SMEs). Their analysis, based on data from the National Stock Exchange and Quotation Centre of China, reveals that venture capital support can aid SMEs in securing augmented bank financing, particularly under favorable circumstances. This finding implies that venture capital backing can exert a significant influence in alleviating financing constraints for SMEs, thereby enhancing their access to essential funds. J. Wang et al. (2023) delved into how venture capital impacts investment efficiency in high-tech industries. Their research, employing the propensity score matching – a difference in differences method, demonstrates that venture capital can ameliorate financing constraints in high-tech sectors, thereby contributing to enhanced investment efficiency.

On the other hand, empirical evidence confirmed the financing methods of bank loans. Kumar and Rao (2016)

empirically found that Indian small and medium-sized enterprises heavily rely on debt, especially short-term debt capital. Similarly, Mancusi et al. (2018) proposed that small and medium-sized enterprises often employ centralized bank borrowing as a strategic approach to address information asymmetry and augment their external financing alternatives. Their research illustrated a robust connection between these enterprises and their principal banks, which heightened the probability and magnitude of their exports. In contrast, Mandler and Scharnagl (2020) contend that the significance of bank financing has been gradually diminishing over time within the Eurozone.

Some scholars even explained why high-tech enterprises choose bank loans or venture capital from the perspective of patents. Hochberg et al. (2018) and Mann (2018) empirically found that loans, particularly those secured with patents, were progressively emerging as a noteworthy financing avenue for innovative companies. The utilization of patents to secure financing in loan agreements was garnering increasing popularity (Caviggioli et al., 2020). Yang et al. (2023) also discerned that patents could facilitate companies in obtaining loans through pledging arrangements. Wei et al. (2022) contended that patents also fulfilled a role in facilitating access to debt financing for high-tech enterprises. They propose that patents function as signals, conveying the innovative capabilities and technological advantages of these enterprises. Consequently, lenders and creditors perceive patented technologies as valuable collateral, thereby heightening the probability of obtaining debt financing for high-tech enterprises. In contrast, S. Chen et al. (2018) empirically uncovered that patent applications and authorizations wielded a substantial positive influence on the probability of securing venture capital funding in the subsequent year, particularly for high-quality patents within the high-tech industry. This underscores that patents serve as a pivotal gauge of innovation and technological potential, exerting an impact on the investment choices made by venture capitalists.

Capital Structure and Other Financing

Some scholars have examined approaches to alleviate the financing constraints faced by high-tech enterprises from other perspectives besides bank loans or venture capital. Croce et al. (2018) shed light on the positive impact of angel investments on the financing prospects of high-tech start-ups. Their research illustrated that the infusion of angel investments enables these start-ups to access elevated levels of financing. Angel investments function, as a pivotal source of early-stage funding, provided the essential capital to bolster the growth and development of high-tech enterprises. Ferrucci et al. (2021) delved into the influence of a central guarantee fund on the survival and advancement of innovative start-ups in Italy. Through an analysis of balance sheet data and usage details of the central guarantee fund for Italian small and medium-sized enterprises, they discerned that innovative start-ups derive greater benefits from the fund in comparison to similar control companies. This suggested that the central guarantee fund serves as a valuable resource in mitigating financial constraints and fostering the progress and evolution of innovative start-ups. L. Li et al. (2019) explored the ramifications of government R&D subsidies on the financing strategies of innovative startups in China. Their empirical analysis uncovered a certification effect linked to the acquisition of government R&D subsidies. Startups employed these subsidies as a legitimate tactic to showcase their innovation and viability to banks, thereby augmenting their prospects of securing bank financing. This discovery underscores the role of government support in invigorating financial access and alleviating the financing constraints encountered by high-tech enterprises. Yan and Liang (2023), Liu et al. (2022), and Q. Wang et al. (2023) empirically found that the supply chain finance could alleviate the financing constraints of SMEs.

From the kinds of literature, there were various opinions on the financing of high-tech enterprises. It can be seen that an ongoing academic debate surrounded the choice between banking and venture capital for financing high-tech enterprises in the start-up stage (De Bettignies & Brander, 2007). The reason for the academic debate is that each viewpoint is unique under specific financial systems and macroeconomic conditions. Financing methods should remain intertwined with the financial system of the region in which the enterprise operates and the prevailing macroeconomic conditions irrespective of the chosen financing methods (Daskalakis et al., 2017; Panova, 2020). National loan infrastructure, encompassing information, legal frameworks, taxation, and regulations, all exerted an impact on the capital structure of enterprises (McNamara et al., 2017). High-tech enterprises may have different financing choices during their start-up stage under different financial systems and macro conditions. The financing issues for high-tech enterprises are relatively complex with highly concentrated banks and less developed capital markets in China. A universally applicable capital structure may not adequately cater to all high-tech companies, particularly those in their nascent stages (Myers, 2001; Neville & Lucey, 2022). Therefore, studying the financing choices of Chinese high-tech enterprises will provide some inspiration for the financing of high-tech enterprises in developing countries.

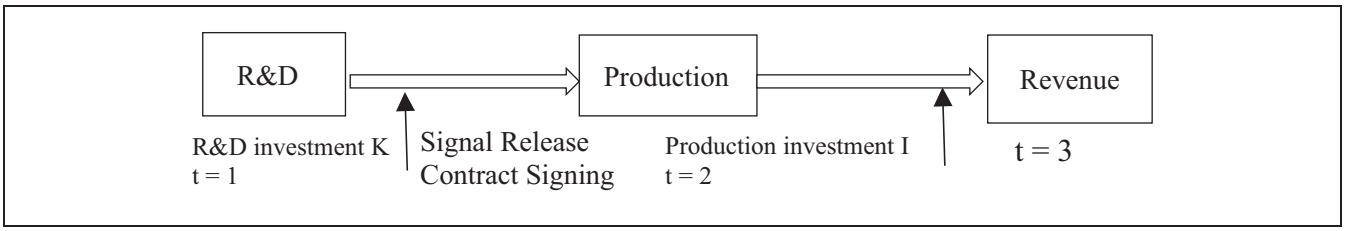

Figure 1. Three stages of high-tech start-up enterprises.

Theoretical Framework and Methodology

In this section, we construct a three-stage financing selection model, drawing upon two lines of literature. Firstly, several scholars have explored financing from an enterprise perspective. Bertoni et al. (2015) and Gafrej and Boujelbéne (2022) formulated a model to investigate entrepreneurs' choices of venture capital, without considering bank loans. Bagella and Becchetti (1998) established a signaling model to assess five potential financing strategies (direct bonds, bonds with equity warrants, convertible bonds, direct equity, short-term bonds at the beginning of the period, and equity at the period's end, and venture capital). Bolton and Freixas (2000) developed a traceable equilibrium model for the capital market encompassing the banking sector and primary securities market under information asymmetry. In this equilibrium state, firms with higher risks tend to favor bank loans, those with lower risks lean toward the bond market, and those in between prefer issuing stocks and bonds. Ueda (2004) introduced a model for entrepreneurs to choose financing from either banks or venture capitalists but with a financing selection sequence from banks to venture capitals. Kwon et al. (2018) formulated a single-stage high-tech enterprise financing model with fuzzy signals, analyzing financing from the angles of equity share, expected profits, and balanced patent level. Bertoni et al. (2019) devised a two-step selection model addressing the context of thin venture capital markets. Their research highlights that the availability of venture capital reduces the likelihood of firms entering the venture capital market, yet it does not decrease the likelihood of seeking venture capital for financing. These findings underscore the persistent significance of venture capital in extending financial support to high-tech enterprises.

Conversely, certain authors have approached financing from an investor or dual perspective. Leshchinskii (2010) established a portfolio model for selecting venture capital and angel funds between two enterprises. Landier (2003) introduced a bidirectional selection model involving entrepreneurs and investors. However, issuing bonds and other products in China entails stringent requirements. During the startup phase of high-tech enterprises, their issuance conditions often fail to meet the prescribed criteria. Consequently, bank loans and venture capital remain their primary external financing sources. In our investigation, we not only delve into the selection of venture capital by high-tech enterprises but also delve into the choices of bank loans and the selection between them. Gromb and Scharfstein (2001) developed a model incentivizing management, which determines whether managers are transferred from their positions or forced into the labor market in the event of project failure. This situation rarely arises because senior managers of early-stage Chinese high-tech enterprises typically serve as controllers of the company. Holmstrom and Tirole (1997) devised a model where financial intermediaries can monitor an entrepreneur's effort, and collateral becomes a requisite by the bank. Repullo and Suarez (2004) presented a model examining the relationship between venture capitalists and investors.

China's banking system is predominantly characterized by a few major banks, and its capital market remains comparatively less developed. Hence, we have opted to investigate solely two types of financing modes – bank loans and venture capital, a choice akin to that of Landier (2003) and Ueda (2004). To accommodate the intricate nature of China's financial system, we have chosen a three-stage model. In this model, we categorize high-tech start-ups into three phases: the Research and Development (R&D) phase, the Production phase, and the Profit Phase, as shown in Figure 1 (It is important to note that the seed and mature stages are not addressed in the paper). The high-tech enterprises in the seed and mature stages are not subjects of this research.

This assumption considers the signing of the financing contracts taking place in the period $t = 2$, which is after the Research and Development (R&D) phase and at the commencement of the production phase. Why isn't the possibility of signing the financing contract during the R&D phase, specifically in the period $t = 1$, being considered? This is because high-tech companies typically acquire their core technology, patented technology, or other intellectual property rights after a period of R&D in China. When it becomes essential to transform these intellectual property outcomes into productive ventures,

a substantial amount of capital investment becomes imperative. During this phase, high-tech companies often encounter insufficient funds, promoting the need for financing to fulfill their requirements.

Bank financing and equity financing serve as the primary sources of funds for start-ups and risky enterprises (Petersen & Rajan, 1995). For simplicity, this paper considers two representative financial products: bank loans and venture capital. The issuance of corporate bonds by Chinese companies is subject to stricter regulations, making it difficult for general enterprises to issue corporate bonds during the start-up stage. Assuming that all participants are risk-neutral (Winton & Yerramilli, 2008), the risk-free investment rate of return on capital is normalized to zero. The enterprise raises the capital required during the R&D period. Given that most start-up companies lack external financing, initial investments are sourced from entrepreneurs' savings (Chyruk, 2009). The required investment I during the production period is normalized to 1 unit in this paper, following a similar approach to Jia (2015).

Let's assume that the entrepreneur is focused on a single project requiring financing, which falls into two categories: good projects with a high probability of success (indicated by G) and bad projects with a lower probability of success (denoted by B). If funding is secured during the production period ($t = 2$), the project will generate revenue at phase $t = 3$.

The project's return on investment is R, if the project succeeds, it generates a return $I \times R$ (normalized I), while failure results in a return of zero (It is assumed that both good and bad project have the same rate of return. The distinction lies in their success probabilities, with good projects having higher success rates than bad projects. In other words, if a bad project were to succeed, its return would be R). We assume that the success probability of a good project is p_1, and that of a bad project is p_2, with $p_1 > p_2$. For an enterprise's project, the probability of being a good project is denoted as α, while the probability of being a bad project is $1 - \alpha$.

Due to information asymmetry, the project managers are intimately familiar with the projects they oversee. This familiarity allows them to determine whether a project falls under the category of a good project (G) or a bad project (B). However, as financing contracts are executed after the Research and Development (R&D) phase, investors are left to make inferences based solely on the information disclosed by entrepreneurs to gauge the project's nature. In the realm of high-tech enterprises, the extent of information that can be disclosed mainly revolves around intellectual property. This disclosure comprises signals classified into three types: signals for good projects (designated as H), signals for pending projects (projects not yet categorized as good or bad, indicated as M), and signals for bad projects (denoted as L). When an entrepreneur discloses the H signal for a good project, they reveal only the proportional information ζ relating to the entire positive project. Similarly, when the L signal is disclosed, it includes the proportional information ζ associated with the negative project. For projects signaled by M, they might belong to either the good or bad category, with investors being informed only about the likelihood of each type.

Consequently, investors can only determine whether the real type (i) corresponds to a good or bad project based on the signal θ disclosed by the entrepreneur, where $\theta \in \{H, M, L\}$.Utilising Bayes' theorem, $p(i = G|\theta = M)$ and the probability of $i = B$ is $1 - p(i = B|\theta = M)$, with both probabilities subject to the parameter α

The equilibrium of the model is based on the following assumptions.

Assumption 1: $p_1 R > p_2 R > 1$

The first two terms of assumption 1 indicate that the expected return of a good project is higher than that of a bad project, which aligns with reality. Since $p_1 > p_2$, we assume that the return on investment for a successful project and a successful bad project is equal to R, establishing the first two components of the inequality. Both good and bad projects yield returns greater than 1 after successful implementation, irrespective of their initial quality. Successful projects can yield substantial returns due to the inherent attributes of high-tech companies, which often drive technological innovation and lead the market. Despite the high risks associated with innovation, successful ventures can generate substantial benefits that surpass the initial investment. The distinction between a good and bad project lies in the high likelihood of success, whereas bad projects have a low probability of success.

Assumption 2: $\chi \times 1 > w$

The variable w is used to represent the wage income of the entrepreneur, encompassing the returns corresponding to the various efforts entrepreneurs exert while operating projects, which include wages and assorted benefits. We use the term "wage returns" (w) to simplify the representation of these costs. The symbol χ signifies the private benefit received by the entrepreneur when they do adhere to the contract. We set χ within the range of $(0, 1)$, and assuming a linear relationship between private benefits and the amount of investment received. For instance, when an entrepreneur secures an investment, the absence of oversight and incentives might lead them to divert funds into projects they anticipate will

yield higher personal gains (Sahut et al., 2021). We posit $\chi > w$, signifying that in the absence of supervision and incentive mechanism, entrepreneurs possess an incentive to breach contractual obligations and deviate from the original effort required to run a project. They might redirect funds to other areas in pursuit of greater benefits. This assumption mirrors real-world economic activities. The greater the value of χ, the stronger the entrepreneur's motivation to pursue personal interests, consequently heightening the project's risk and making project financing more stringent. Consequently, the project may fail to secure the amount of financing anticipated by the entrepreneur.

Optimal Contract Selection

Due to information asymmetry, we are presenting design financing contracts in this section that are suitable for banks or venture capital institutions. This is following the business characteristics of these entities. We are assuming that the expected return for the investor regarding the entrepreneur's efforts in the project is denoted as y. In other words, the investor believes that a reward of y should be given to the entrepreneur for their contributions to the project's operations

Optimal Contract for Bank Financing

Due to information asymmetry, moral hazards are present in the execution of the contract. Simultaneously, owing to the limitations in professional knowledge, banks may not fully comprehend the entrepreneur's project. The bank also refrains from participating in the project's management and control during its implementation (Bertoni et al., 2019). If the entrepreneur breaches the contract, the project might deviate from its original business direction, or effort may be reduced, leading to losses for the bank. To mitigate these risks, banks usually resort to asset mortgage loans or impose limits on loans under asymmetric information. Given that high-tech enterprises tend to possess fewer tangible assets, this paper does not consider the asset-backed loan model. Instead, it focuses solely on the loan quota method or determining the loan amount by converting intellectual property rights into market prospects.

To avert the occurrence of moral hazard, banks incorporate measures to filter out unfavorable projects when crafting contracts. This ensures that projects sending out L or M signals, which indicate lower quality, do not receive financing. Banks exclusively extend loans to projects emitting H or M signals, indicating higher quality. Assuming the bank incurs no costs in identifying these signals and gathering information, the net income of the bank loan contract can be expressed as follows:

$$\max_{I_\theta \in [0,1], y_H, y_M} \overline{U}^B = \alpha\zeta(p_1R-1)I_H + \alpha(1-\zeta)(p_1R-1)I_M - \alpha p_1\zeta y_H - \alpha(1-\zeta)p_1 y_M$$

The objective function complies with the following constraints:

$$\alpha\zeta p_1 y_H + \alpha(1-\zeta)p_1 y_M \geqslant w \quad (1)$$

$$\alpha\zeta p_1 y_H + \alpha(1-\zeta)p_1 y_M \geqslant \chi I_\theta \quad (2)$$

$$p_1 y_M | \{i = B, \theta = M\} \leqslant w \quad (3)$$

$$\chi I_M \leqslant w \quad (4)$$

Equation (1) represents the participation constraint, signifying that the entrepreneur can only accept the contract when the expected reward offered by the contract is greater than or equal to the expected reward gained from an investment. Equation (2) corresponds to the incentive compatibility constraint, indicating that the entrepreneur will adhere to the contract and diligently oversee the project under the circumstance that the anticipated reward is greater than or equal to their interests. In these situations, the likelihood of moral hazard is minimized. Equations (3) and (4) serve to eliminate poor projects that present ambiguous signals to secure financing. This implies that if a subpar project employs M signals to acquire loans, their potential returns would be lower than or equivalent to the expected returns envisioned by the entrepreneurs. Hence, entrepreneurs would refrain from engaging in such projects. Additionally, if the gains an entrepreneur obtains through breaching the contract are inferior to the project's profits, there would be no motivation for them to violate the contract. This circumstance also mitigates the risk of moral hazard.

To err on the side of caution, equation (3) assumes that a subpar project exhibiting the M signal has an equivalent probability of success as a high-quality project. This implies that even if the M signaled project achieves remarkable success, its earnings would remain less than or equal to the compensation deserved by the entrepreneur, dissuading them from accepting the contract. Assuming equality in equation (4) we deduce that $I_M = \frac{w}{\chi}$. Simultaneously, in the case of a strong project, the full loan amount would be acquired, resulting in $I_H = 1$. The solution for the objective function can be derived as follows:

$$\overline{U}^B = \alpha\zeta(p_1R-1) + \alpha(1-\zeta)(p_1R-1)\frac{w}{x} - \max\{w, \chi(\alpha\zeta + \alpha(1-\zeta)\frac{w}{x})\}$$

Optimal Contract for Venture Capital Investment

Venture capital institutions possess industry expertise, setting them apart from banks. When an institution investor with an inclination for risk considers an investment in a particular project, it becomes imperative for the institution to hold a specialized knowledge background in the respective field (Bertoni et al., 2015). Furthermore, they must possess ample human resources to decipher the genuine nature of a project based on the underlying information conveyed by the entrepreneur. Such institutions actively engage in project management and might even assume control when the project is confronted with risk. Consequently, venture capital operations tend to exhibit a relatively high degree of certainty concerning a project's classification, rendering moral hazard nearly inconsequential. Venture capital investors are capable of structuring contracts to screen out undesirable projects with L or M signals while fully investing in promising projects exhibiting M or H signals. It should be acknowledged, however, that the negotiation demands higher costs for venture capital institutions compared to banks. Let's assume that c represents the cost associated with screening signal M. In this context, the net income derived from the venture capital contract can be expressed as follows:

$$\max_{I_\theta \in [0,1], y_H, y_M} \overline{U}^{VC} = \alpha\zeta(p_1R-1)I_H + \alpha(1-\zeta)(p_1R-1)I_M - (1-\zeta)c - \alpha p_1\zeta y_H - \alpha(1-\zeta)p_1y_M$$

The objective function meets the following constraints:

$$\alpha\zeta p_1y_H + \alpha(1-\zeta)p_1y_M \geqslant w \quad (5)$$

$$\alpha\zeta p_1y_H + \alpha(1-\zeta)p_1y_M \geqslant \chi I_\theta \quad (6)$$

$$p_1y_M|\{i=B,\theta=M\} \leqslant w \quad (7)$$

$$\chi I_M \leqslant w \quad (8)$$

Equation (5) represents the participation constraint, which signifies that the entrepreneur can only accept the contract when the expected reward offered by the contract is greater than or equal to the expected reward received by the entrepreneur. Equation (6) serves as the incentive compatibility constraint, indicating that the entrepreneur will adhere to the contract and exert effort to operate the contracted project when the expected reward matches their private interests, thus preventing the occurrence of moral hazard. Equation (7) function is to eliminate poor projects that provide ambiguous signals to secure loans. It stipulates that if bad projects emitting M signals obtain loans, their income must be less or equal to the income expected by the entrepreneur. Consequently, the entrepreneur would decline involvement in such projects.

As a precaution, equation (7) assumes that a bad project with the M signal has an equal chance of success as a good project. This means that even if the M-signaled bad projects achieve significant success, they can only yield returns that are less than or equal to the income the entrepreneur should receive. Consequently, the entrepreneur would decline the contract. Equation (7) implies $p_1y_M = w$, leading to $y_M = \frac{w}{p_1}$. Given that the venture capitalist has accurately discerned the true nature of the project, in the scenario of full investment in a good project, $I_H = 1$ and $I_M = 1$. The solution to the objective function is:

$$\overline{U}^{VC} = \alpha(p_1R-1) - (1-\zeta)c - \max\left\{w, \chi(\alpha\zeta + \alpha(1-\zeta)\frac{w}{\chi})\right\}$$

Choice Between Two Types of Contracts

The distinction between a bank contract and a venture capital contract lies in the bank's lack of clarity regarding the true type of the project. It can only judge the type of the project through signals, and there are no measures in place to prevent moral hazard after the investment. As for venture capitalists, due to their professional industry knowledge, they can avoid moral hazards by participating in project management. Additionally, venture capitalists can establish connections with suppliers and potential customers, attract critical personnel, offer strategic and marketing counsel, and aid businesses in the specialization. While these benefits provide entrepreneurs with substantial support, they come at a considerable cost, potentially involving the relinquishment of equity or even the loss of management control over the company.

If ζ increases, it indicates more comprehensive information disclosure and reduced information asymmetry between investors and entrepreneurs. Consequently, the expected net income of both contract types will increase. Conversely, If χ decreases, it signifies a relatively small occurrence of moral hazard. In the case of bank loans, this would lead to obtaining more loans and increasing the net income of both contract types.

Inference 1: If the net income of venture capital exceeds that of the bank, then,

(a) $c < \alpha(p_1R-1)(1-\frac{w}{\chi})$
(b) Building upon equation (1), if we maintain c at a constant value and decrease ζ, we effectively increase the degree of information asymmetry. The signifies the professional advantages held by venture capital investors.

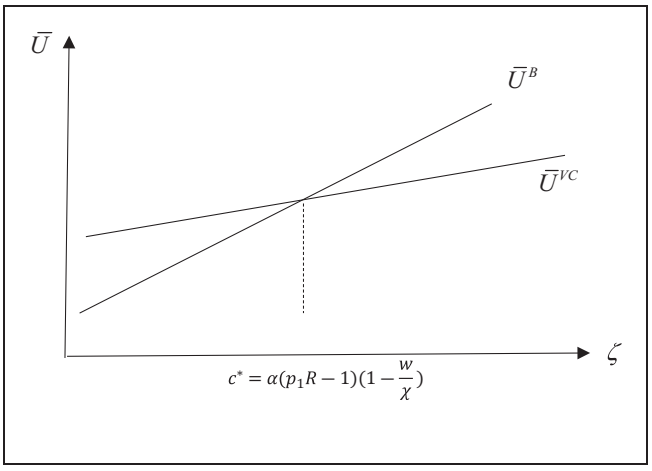

Figure 2. Comparison of the degree of information transparency.

(c) Increasing χ indicates a rise in moral hazard. Due to the inability of bank investors to actively participate in project management and control, underlying risks escalate. In contrast, venture capital investors can mitigate moral hazard by actively engaging in internal management and control.

(d) Augmenting p_1, thereby leveraging professional guidance and other methods to enhance the probability of success.

Proof:

$$\overline{U}^{VC} - \overline{U}^{B} = \alpha(1-\zeta)(1-\frac{w}{\chi})(p_1R-1) - (1-\zeta)c \quad (9)$$

To make $\overline{U}^{VC} - \overline{U}^{B} > 0$, we can derive the following expression,

$$c < \alpha(p_1R-1)(1-\frac{w}{\chi})$$

Inference 1 (b), (c), and (d) can be derived from equation (9).

From Figure 2, it becomes evident that when the supervision cost $c^* = \alpha(p_1R-1)(1-\frac{w}{\chi})$. On the left side of c^*, as the information transparency (ζ) decreases, choosing venture capital financing becomes more favorable. This supports the findings of C. Li and Zhou (2022) and Hogan et al. (2017). In other words, when information asymmetry exists between banks and borrowers (high-tech companies), high-tech companies tend to rely more on external equity (venture capital) for funding.

On the right side of c^*, as information transparency increases, opting for bank capital financing becomes more suitable, aligning with Coleman and Robb (2012). This implies that well-performing companies often utilize significant debt in their initial stages. Essentially, if a high-quality high-tech enterprise seeks bank loans, the more comprehensive the information disclosure, the higher the likelihood of securing loans under the same condition.

An Example: Empirical Explanation of the Financing Situation of Chinese High-Tech Enterprises

The data is sourced from companies listed on the Science and Technology Innovation Board within the Choice database of Eastmoney Company, spanning from 2006 to 2019. The Chinese Sci-Tech Innovation Board was established in 2019, employing a registration system for listed companies. As such, the listing requirements for high-tech companies on this board are relatively less stringent compared to other sectors. The rationale for selecting companies from this sector is high-tech companies. This eliminates the need to sift through samples from other sectors. Furthermore, the data selected exclusively pertains to or predates 2019, ensuring that none of these sample companies were listed entities, implying that their information had not undergone capital-related scrutiny or maximum disclosure. Initially, the collected sample encompassed 525 high-tech companies. After excluding incomplete financial data during the specified period, the effective samples consist of 477 high-tech companies. The venture capital ownership shares of these high-tech companies were manually compiled. This compilation involved cross-referencing the list of the top ten shareholders of these companies with the list of investment institutions in Wind Investment Bank Data to ascertain whether the shareholders listed were indeed venture capital institutions. If an entry wasn't found in the list of investment institutions, we searched for the content of the business scope of the National Enterprise Credit Information Publicity System (www.gsxt.gov.cn). In cases where the business scope description contained terms such as risk investment or entrepreneurial investment, the institution was categorized as a venture capital entity. The patent data of the companies was obtained from the Chinese National Intellectual Property Administration (www.cnipa.gov.cn).

The graph depicting the loan amount and the portion funded by venture capital for the sample companies is presented in Figure 3. Observing Figure 3, it is apparent that the overall loan volume for high-tech enterprises has consistently grown over the years. Since 2016, this growth rate has intensified; however, the growth rate of long-term loans is significantly smaller compared to that of short-term loans. Additionally, the data highlights that high-tech companies secure a greater amount of short-term loans in comparison to long-term loans. This

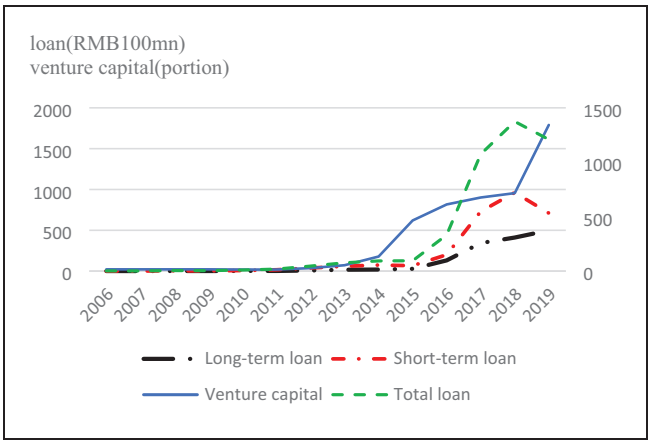

Figure 3. Line chart of loan and venture capital amounts.

indicates that high-tech companies find it comparatively easier to obtain short-term loans, a situation that might not be conducive to their long-term development.

Figure 3 also indicates an ascending trend in the portion attributed to venture capital. Notably, the growth rate of the venture capital portion has been particularly substantial since 2014. This growth was especially pronounced from 2018 to 2019, which might be associated with the establishment of the Chinese Sci-Tech innovation board in 2019.

To explore the financing preferences of high-tech companies before listing – choosing between bank loans and venture capital as the explained variables, the variables include loan scale (Lev = loans/total assets, assigned a value of 1 if the loan amount is greater than 0, otherwise, 0), venture capital (Venture, assigned a value of 1 if the share is greater than 0, otherwise, 0). The explanatory variable is the number of company patents (lninnovation = ln [1 + number of patents]) indicating the development potential of enterprises. The control variables include asset-liability ratio (Asset_liability) reflecting the safety level of loans issued by creditors, return on total assets (ROA) evaluating the profitability of the enterprise, liquidity ratio (Liquid) reflecting the short-term solvency of the enterprise, enterprise size (Size = ln [total assets at the end of the period]), collateral (Fix_asset = fixed assets/total assets) indicating loan capability, company age (ln Age = ln [year of establishment − 2019 + 1]). Additionally, to control for the heterogeneity among provinces, we incorporate each province's financial development as a macro variable (D. Chen et al., 2016)—defined as the ratio of a province's total bank loans to its GDP, Financial Index (source: Almanac of China's Finance and Banking). We also included per capita GDP (lnGDP = ln[GDP]), and the GDP growth rate of each province (GDP_growth) (source: National Bureau of Statistics www.stats.gov.cn) as macroeconomic control indicators.

After Winsorising the collected enterprise data at the 1st percentile on the left and the 99th percentile on the right, we provide the descriptive statistics for all data, as shown in Table 1. The count of companies with bank loans exceeds the count of companies with venture capital. Furthermore, within the venture capital group, a significant number of companies also employ bank financing. As a result, overall, the number of companies opting for bank financing is relatively higher.

The analysis reveals that the company age at the 50th percentile is 13 years, the 75th percentile is 16 years, and the company age at the 90th percentile is 18 years. As a result, the majority of high-tech companies are relatively young.

To explore the financing preferences of high-tech companies, we utilize a regression analysis that considers bank loans and venture capital as the dependent

Table 1. Descriptive Statistics of Variables.

	Venture = 0 (*N* = 1,607)				Venture = 1 (*N* = 454)			
Variable	Mean	*SD*	Min	Max	Mean	*SD*	Min	Max
Lev	0.09	0.12	0	0.52	0.08	0.09	0.00	0.42
ROA	0.08	0.15	−0.60	0.40	0.09	0.11	−0.60	0.40
Asset_liability	42.97	22.61	5.58	110.08	36.43	19.63	5.58	110.08
Liquid	2.88	2.88	0.41	20.92	3.85	4.05	0.47	20.92
Size	5.98	1.20	3.37	9.80	6.38	0.98	3.71	9.8
lninnovation	1.36	1.20	0.00	4.73	1.60	1.19	0.00	4.73
Fix_asset	0.17	0.15	0.00	0.65	0.15	0.14	0.00	0.64
lnAge	2.47	0.41	0.69	3.00	2.56	0.32	1.39	3.00
Financial_index	1.59	0.49	0.68	6.24	1.62	0.80	0.77	15.83
lnGDP	10.69	0.60	7.81	11.59	10.76	0.62	8.43	11.59
GDP_growth	7.36	1.24	0.50	13.90	7.11	1.34	2.80	15.60

Table 2. Regression Results.

Variable	Lev	Venture
ROA	−1.027** (−2.20)	
Asset_liability	0.016*** (3.65)	−0.017*** (−6.23)
Liquid	−0.232*** (−5.49)	
Size	0.343*** (5.71)	0.312*** (6.97)
Fix_asset	0.968** (2.13)	
lninnovation	0.122*** (2.62)	0.086** (2.13)
lnAge	0.031 (0.18)	0.669*** (4.75)
Financial_index	−0.453*** (−2.74)	
GDP_growth	0.046 (0.37)	
lnGDP	0.095 (1.48)	
_cons	−2.178 (−1.20)	−4.385*** (−9.65)
N	1,629	2,061
Clas	74.52%	77.78%

***$p < .01$.**$p < .05$.

variables, respectively. Therefore, we have formulated the model as follows:

$$Y_{i,t} = \beta_0 + \beta_1 lninnovation_{i,t} + A_i X_{i,t-1} + B_i Z_{i,t} + \varepsilon_{i,t}$$

In the formula, $Y_{i,t}$ represents the scale of bank loans and venture capital, respectively; $lninnovation_{i,t}$ is the number of patent applications in the current period; $X_{i,t-1}$ represent the relevant micro-indices of the firm: asset-liability ratio, return on total assets (ROA), current ratio, firm size, collateral, and firm age (in log); Zi,t are control variables to control for differences between provinces. They are the relative scale of bank loans in a province (Financial index), GDP per capita (GDP in log), and the GDP growth rate of each province (GDP growth rate). β_0, β_0, A_i, B_i are the constant term and the coefficient of each variable, respectively. ε_i represents independently and identically distributed variables.

The loan scale and venture capital are utilized as dependent variables for performing logit regression. As indicated in Table 2, the total loan scale is significantly associated with total assets (ROA), liquidity ratio (Liquid), enterprise size (Size), and collateral (Fix_asset), which indicates that the growth strength of a company can enhance its' bank loans financing capacity. Additionally, there is a notable negative correlation with variables reflecting financial development. This implies that loans acquired by high-tech enterprises exhibit an inverse relationship with the loan quotas approved by the central bank in this region. Moreover, the share of venture capital demonstrates a negative correlation with the asset-liability ratio (Asset_liability), suggesting a substitute relationship between loan financing and venture capital financing. Notably, the share of venture capital is significantly and positively correlated with the size and age of the company. This suggests that larger high-tech with a longer operating history tend to possess stronger foundations, thereby enhancing their ability to attract venture capital. Furthermore, a positive and significant relationship exists between the share of venture capital and the number of company patents (lninnovation), underscoring the importance of patent count as a key indicator for assessing the growth prospects of high-tech companies. These results indicate that venture capital evaluates the growth of enterprises.

In conclusion, it is evident that within the present Chinese financial system landscape, bank loans and venture capital are the potential financing avenues of choice for Chinese high-tech enterprises. Each enterprise selects the most suitable option based on its unique characteristics and the local environment to better foster company development. The greater the disclosure made by high-tech early-stage enterprises, the more likely they are to obtain bank loans; otherwise, they will attract more venture capital financing.

In this paper, one-period lags of firm-related variables are utilized to test for endogeneity. Both probit and logit regressions are employed, utilizing invention patents instead of the total number of patents. The results demonstrate the reliability of the regression mode. Due to space constraints, the results are not provided here (but can be supplied upon request).

Conclusions and Discussion

The study findings suggest that the primary factors influencing the financing efficiency of high-tech companies in their start-up phase encompass the project's probability of success, expected project returns, information disclosure status, supervision costs, and moral hazard, among others. Under conditions of full information, when high-tech companies in their start-up phase constitute sound projects, both bank financing and venture capital financing are viable options. The findings indicate that bank financing outperforms venture capital financing in these scenarios. Conversely, when there is information asymmetry prevails and/or when a high-tech start-up is categorized as a subpar project, financing via venture capital becomes more suitable. Hence, high-tech enterprises select between bank loans and venture capital according to their development characteristics.

The research deduces that in developing countries such as China, characterized by an imperfect financial system dominated by large banks, both bank financing and venture capital financing will co-exist for an extended period. This viewpoint is consistent with Coleman and Robb (2012) and Neville and Lucey (2022). Coleman and Robb (2012) posited that technology companies can leverage both debt and equity financing extensively in their entrepreneurial years. Similarly,

Neville and Lucey (2022) asserted that no singular capital structure fits all high-tech companies, especially fledgling ventures.

Policy-making entities can shape supportive and regulatory measures tailored to the distinct factors influencing high-tech start-up financing in China. Examples include establishing specialized banks for high-tech enterprises, cultivating professionals well-versed in high-tech enterprise financing, and refining financial policies, legal frameworks, and regulatory systems. Enhanced guidance and supervision of the financial system can contribute to fostering an optimal investment and financing environment. Additionally, leveraging novel technologies can enhance credit transparency for high-tech companies and mitigate moral hazards.

Naturally, this study has several limitations. The first is the selection of model research objects. The research has chosen bank loans and venture capital as research objects, excluding bonds because of the Chinese government's very high requirements for bond financing for entrepreneurs. The bond financing strategic choices of the entrepreneurs will be studied in the future with the Chinese government lowering the financing requirements. The second is specific enterprise numbers for obtaining successful financing in venture capital and at what stage of enterprise development, which is for future study.

Policy Suggestions

Venture capital offers distinct advantages in financing start-up enterprises, particularly high-tech companies. Bottazzi et al. (2008) argue that non-financial services provided by venture capital play a pivotal role in the success of portfolio companies. Scholars like Jia (2015) propose that venture capital firms hold evident advantages in investing in high-tech firms, especially in countries where commercial bank equity financing is restricted. In nations without such limitations, these advantages diminish. Venture capital financing's key edge over bank financing in high-tech enterprises lies in the establishment within mature financial markets, allowing easier market exit.

The Chinese financial landscape is bank-centric, and equity financing is not as advanced as in developed nations. Moreover, Chinese banks are not permitted to engage in equity financing. Given these conditions, securing financing for early-stage high-tech companies becomes more challenging. Building on the aforementioned theoretical underpinnings, the following policy recommendations are put forth:

(1) *Addressing incomplete and asymmetric information*:
- Government management departments could establish expert teams for professional guidance and project evaluation to enhance project management success and information transparency during investment and financing.
- The Chinese government might establish an intellectual property transaction or evaluation platform for high-tech enterprises, alongside creating professional banks dedicated to investing in specialized fields.
- Incentive measures encouraging more project information disclosure by financing companies could be formulated. Policies facilitating collaboration between banks and venture capital institutions for project financing could be designed.

(2) *Combating moral hazards*:
- The Chinese government could enhance the social credit management and the information disclosure system to penalize and curb law violators creating moral hazards.
- Cultivating an environment encouraging financing companies to proactively disclose business and financial information could be valuable.

(3) *Supporting light-asset, high-risk high-tech start-ups*:
- Relevant government departments could establish special projects aligning with national and local development strategies to support early-stage high-tech enterprises.
- Special support funds and financing guarantee funds could be created to provide policy-based financial aid.

(4) *Enhancing investment and financing environment*:
- The government should refine financial policies, laws, and regulations, fortify financial system guidance and oversight, and establish an inviting investment and financing climate to serve the real economy better.
- Facilitating financial innovation, constructing multi-level financial markets, and broadening the exit channels for angel and venture capital investments are essential.

(5) *Financial technology*:
- Furthermore, government management departments could leverage innovative financial technologies like digital currencies and blockchain to enhance credit transparency for high-tech companies and mitigate risks of moral hazard and information asymmetry.

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Data Availability Statement

The data is sourced from companies listed on the Science and Technology Innovation Board within the Choice database of Eastmoney Company, which is subscription-based. The patent data of the companies was obtained from the Chinese National Intellectual Property Administration (www.cnipa.gov.cn).

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