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Nonlinear effects of bank loans on county agrifood SMEs innovation: Empirical evidence from China

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Abstract: Innovation is the driver of sustainable business development and is essential to promote high quality economic development in the country. Are more bank loans better for small and medium-sized enterprises (SMEs) innovation? Therefore, based on mixed cross-sectional data of county sweet potato processing enterprises, this study applied the econometric model to explore the impact of bank loans on county agrifood SMEs innovation. We find that there is an 'inverted U-shaped' relationship between bank loans and county agrifood SMEs innovation. The analysis of the mechanism shows that bank loans can not only alleviate the problem of innovation financing constraints for agrifood SMEs, but also provide financial support for the innovation activities of agrifood SMEs as a result of trade openness. This study has important practical implications for promoting county agrifood SMEs innovation in China and promoting high-quality county economic development.

Keywords: bank loans; SMEs; enterprise innovation; nonlinear relationship; OLS

China's economic development has entered a period of transition from a stage of high growth to high-quality development with technological innovation as the main theme. Technological innovation refers to the process of improving and upgrading existing technologies (Dosi 1982; Nelson and Winter 1982; Damanpour and Gopalakrishnan 2001). Thus, the country has proposed an innovation-driven development strategy. In terms of the geographical scope of innovation, the importance of grassroots science and technology innovation is emphasised in the National Science and Technology Innovation Plan for the 13th Five-Year Plan. The General Office of the State Council promulgated the 'Several Opinions on Innovation-driven Development in Counties', pointing out the important assertion that the foundation for implementing

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the innovation-driven development strategy lies in the counties due to both their vitality and difficulties. This shows the importance of counties in innovation planning.

From the perspective of innovation subjects, enterprises are one of the important forces in enhancing national innovation capacity. In China, SMEs account for 99.8% of the total number of enterprises (Chinese Government website 2022), account for 70% of the total number of patents for inventions, provide 80% of urban jobs, and create 60% of total of GDP (Pingliang Bureau of Industry and Information Technology 2023). It is clear that SMEs are an important force in driving innovation.

As we all know, technological innovation has a long cycle, and SMEs need more stable and continuous financial support than state-owned and large enterprises. However, financing difficulties for SMEs are common globally (Belas et al. 2017; Chiappini et al. 2022; Harrison et al. 2022), and China is no exception. In fact, many factors affect the financing constraints of SMEs, such as the capital market and new financial tools (Aiello et al. 2020), information asymmetry (Song et al. 2020), credit supply (Harrison et al. 2022), digital financial inclusion (Hu et al. 2023; Bu et al. 2024), and differences in size and nature of enterprises (Guercio et al. 2020; Lou et al. 2024). In terms of financing channels, SMEs' financing channels include formal and informal financing, with formal financing mainly consisting of bank loans and informal financing consisting of loans based on personal relationships, from online loan providers, and from other informal institutions (Hu et al. 2024). In terms of financing direction, SMEs financing consists of external and internal financing, where external financing is mainly bank loans and internal financing is mainly retained earnings. Bank loans and internal funds are complementary rather than substitutes in the innovation process of SMEs (Guercio et al. 2020). However, it has also been found that in Nigeria, only external financing can drive R&D expenditure by SMEs (Adegboye and Iweriebor 2018). With the use of new technologies, such as the Internet, the form of bank loans has changed, with the development of peer-to-peer (P2P) lending, which better meets the diversified needs of SMEs financing (Palmieri and Ferilli 2024). In brief, bank loans, due to their reliability and accessibility, are still the preferred source of SMEs' financing (Palmieri and Ferilli 2024), especially for start-ups in the early-stage (Ivanová 2017) and growth-stage SMEs (Yao et al. 2024). Currently, academic studies on the relationship between bank loans and SMEs innovation mainly focus on the credit environment, nature of banks, nature of enterprises, and relationship between government and enterprises, but no unified opinion has been formed.

Some scholars suggest that bank loans can promote innovation in SMEs (Adegboye and Iweriebor 2018; Yu et al. 2022; Haruna et al. 2024). From the perspective of the bank's competitive environment, the continuous competitive development of the banking sector can improve enterprise innovation investment and guarantee the sustainability of innovation investment (Claessens and Laeven 2003; Zhang 2022). From a financing accessibility perspective, the ease of access to bank credit for SMEs can promote their innovative capacity (Adegboye and Iweriebor 2018), especially in terms of technological innovations (process and product) rather than non-technological innovations (marketing and organisation) (Haruna et al. 2024). However, financing accessibility is closely related to lending distance and the collateralisation system. From a lending distance perspective, traditional financial geography theory suggests that bank loan size decreases with distance to SMEs. In other words, local bank branches can reduce the credit constraints of nearby SMEs (Kärnä et al. 2021). However, with the digital development of fintech, the digital transformation of banks can significantly lengthen the lending distance between banks and enterprises and realise the geographical expansion of the lending distance (Tian and Su 2024). From a collateralisation perspective, both equity guarantee swaps (EGS) and credit guarantee schemes (CGS) are beneficial in improving SMEs' access to bank loans, with EGS having a Pareto improvement over CGS (Wang et al. 2022). A study has shown that obtaining a credit guarantee can increase a SME's probability of obtaining bank loans, the loan amount received from banks, and R&D expenditures by 2, 17.4, and 7.6%, respectively (Yu et al. 2022). From the perspective of bank lines of credit, it usually does not require collateral and to some extent meets the flexibility needed to finance an enterprise's R&D project (O'Brien 2003). From the perspective of the nature of banks, countries with a relatively low share of state-owned banks have a stronger positive impact on enterprise innovation activities (Xiao and Zhao 2012). In particular, the entry of small banks has led to changes in the structure of local banks, which are more willing to lend to SMEs, easing their financing pressure and, thus, boosting the patent output of local industries (Strahan and Weston 1998; Xin et al. 2022).

However, other scholars argue that bank loans inhibit SMEs' innovation (Rajan 1992; Berger and Udell 2002; Bakhouche 2022). Using a sample of SMEs in five

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non-oil Arab countries, Bakhouche (2022) found that banking institutions are reluctant to finance innovations in SMEs, considering the credit risk, which inevitably inhibits their innovations. Berger and Udell (2002) suggested that bank loans are a camera governance mechanism that generally restricts enterprise R&D expenditure. From the external environment perspective, Rajan (1992) found that banks charging information rents to enterprises discourages their innovation. Bank liquidity shocks can also have a dampening effect on SMEs' innovative behaviour, such as during the financial crisis of 2008 and 2011 (Spatareanu et al. 2019). From the perspective of the external environment of government-enterprise relations, political connections, as a scarce resource, not only have a crowding-out effect on enterprise R&D investments due to rent-seeking activities (Murphy et al. 1993), but also may lead to the emergence of organisational inertia in enterprises, which tend to adopt old technologies rather than innovate them (Krusell and Ríos-Rull 1996; Zhou 2013). A study also confirmed that government intervention has a negative impact on SMEs' R&D activities (Cai et al. 2016). In addition, other scholars have found that bank lending is not statistically significant for the innovative capacity of SMEs based on the analysis of enterprise type (Belas et al. 2017).

In summary, studies by scholars on the relationship between bank loans and SMEs innovation have yielded rich results, which provide a useful theoretical basis and analytical perspective for this study, but shortcomings remain. At present, academic studies favour the use of data from listed enterprises to explore the impact of market structure and competitive environment of bank loans on innovation in processing, and manufacturing, and high-tech enterprises. However, studies on the impact of bank loans on the county agrifood SMEs innovation at the 'end' of regional innovation systems are rare. On the one hand, China is a large country in terms of agricultural resources and population, and county agrifood SMEs hold an important position in the county economy that cannot be ignored. On the other hand, compared with industrial manufacturing and high-tech enterprises, agricultural processing enterprises have certain differences in capital allocation, labour structure, production process, and product services provided. Due to the influence of agricultural and natural factors, the innovation capability of agricultural processing enterprises is more fragile, and their innovation problems are more pronounced. Using a sample of Australian SMEs, McCarthy et al. (2017) found that agrifood SMEs were more likely to seek bank loans. Therefore, based on the mixed cross section data of county sweet potato processing enterprises (small and medium-sized unlisted enterprises) in the National Sweet Potato Industrial Technology System, this study applied the Tobit model to explore the impact of bank loans on county agrifood SMEs innovation.

Compared to previous studies, the possible contributions of this study are as follows. First, according to the planning needs of China's implementation of the innovation-driven development strategy, innovation activities carried out at the county level are very important. Therefore, the findings of this study are useful in helping the relevant government departments improve their understanding of innovation in agrifood SMEs at the county level and in related policy formulation and implementation. Second, the study using micro research data of sweet potato processing enterprises at the county level can complement the findings of the data study of listed enterprises. Third, the number of patents (output indicator) is used to measure agriculture SMEs innovation, and technology R&D investment (input indicator) is used as a robustness test, taking full account of model endogeneity issues. Finally, the intrinsic micro-mechanisms are revealed from the two dimensions of financing constraints and trade openness, which provide useful practical exploration to promote further improvement of the innovation capacity of county agrifood SMEs.

Theoretical analysis and research hypothesis. Currently, the sources of funding for enterprise innovation are internal and external financing. From the stage of enterprise development, internal financing is usually chosen in the early stage, and external financing is preferred when entering the capital-intensive stage (Lin and Li 2001). The study by Wang et al. (2017) also confirmed that most Chinese enterprises have insufficient internal financing for R&D activities. Therefore, external financing has become an indispensable source of funding for enterprise innovation (Czarnitzki and Hottenrott 2011), of which bank loans are predominant (Allen et al. 2005). From the current structure of China's financial market, banks are the main source for enterprises to obtain external financing, which is difficult to change in the short term. There are three main reasons. First, according to the pecking order theory, entrepreneurs prefer debt financing when internal financing is insufficient due to controlling interest considerations (Bartoloni 2013). Second, banks have an information advantage that reduces the cost of external financing for enterprises (Diamond 1984). Third, banks have a strict system for protecting trade

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secrets to avoid leakage of enterprise R&D information to competitors (Benfratello et al. 2008).

In fact, innovation is an endogenous choice and strategic behaviour of enterprises arising from their own development. During the national economic transition, it is a revolutionary market reshuffle for Chinese enterprises, and it is a law of nature that the fittest will survive. In particular, SMEs need to improve their innovation capabilities and take the initiative to adapt to fierce market competition. Traditional innovation theory suggests that financial constraints force enterprises to reduce R&D expenditures and abandon projects with positive net present value (NPV), and that more financial resources can increase the funds available for R&D (Arrow 1972). However, compared to developed countries, the level of financial development in China is relatively backward, so an important obstacle facing enterprises is the difficulty of obtaining external financing (Banerjee and Duflo 2010). First, from the banking system perspective, China's financial system is currently dominated by state-owned banks. It is well known that banks are generally reluctant to invest capital in enterprises with low debt repayment capacity. State-attributed enterprises are inherently a certified sign of lower lending risk (Marti and Quas 2018) and often have preferential access to bank loans and enjoy lower interest rates (Allen et al. 2005). This leads to difficulties in obtaining bank loans to support SMEs and hinders the development of their innovative capabilities (Lin and Li 2001; Xue et al. 2016). Second, innovation financing theory suggests that enterprises' innovation projects face higher external financing costs due to the difficult in monitoring the moral hazard of entrepreneurs by external investors, lack of collateralisable physical assets, and high uncertainty about future outputs (Hall and Lerner 2010). In other words, considering risk control, banks have developed a strict loan review mechanism, which considers the qualifications of the lending enterprises (hard information), such as asset reports, collateral, and production scale. For SMEs, these aspects are far inferior to those of state-owned and large enterprises. Meanwhile, China's banks are dominated by enterprises of state-owned nature and thus prefer to allocate loans to state-owned enterprises (Xiang et al. 2021). Finally, based on the analysis of enterprise attributes, compared to other types of enterprises, agrifood SMEs face long investment cycles and high risks due to factors such as agricultural attributes and climate uncertainty (Li et al. 2024). This means that agrifood SMEs are more likely to seek bank loans to alleviate funding shortfalls in innovation (McCarthy et al. 2017). Therefore, the accessibility of bank loans is crucial for driving innovation in SMEs.

However, there is one question that deserves to be explored in depth: is there a simple linear relationship between bank loans and SMEs innovation? In fact, bank loans do not necessarily promote enterprise innovation, and only under certain conditions can the two play a positive feedback 'chemical effect' (Xue et al. 2016). Compared to state-owned and large enterprises, SMEs are less able to take market, financial, and innovation risks. In addition, the amount of bank loans obtained by SMEs under the same conditions is bound to differ significantly due to differences in industry, nature of the enterprise, social connections, etc. If the scale of SMEs bank loans exceeds their risk capacity, they become highly indebted and face a debt crisis. For highly indebted enterprises, a cautious approach to innovation decisions is generally adopted, resulting in less innovation (Wang 2002). In contrast, smaller bank loans lead to insufficient funds for innovation activities and make it difficult to achieve an optimal allocation of R&D resources. Based on the above analysis, the following hypothesis is proposed:

H_1: There is an 'inverted U-shaped' relationship between bank loans and agrifood SMEs innovation.

In addition, bank loans can provide sufficient financial support for agrifood SMEs to carry out innovative activities, but the size of the loans is easily influenced by financing constraints. The fundamental reasons for the financing constraints of SMEs are as follows: on the one hand, SMEs are characterised by their small scale of operation and low capital; on the other hand, there is information asymmetry between SMEs and banks, which leads to banks' financial exclusion of SMEs and makes them face a shortage of funds (He et al. 2024). First, from the enterprise perspective, R&D activities are characterised by high risk, externalities, long lead times, high costs, and unpredictable future expectations (Hall and Lerner 2010). Therefore, enterprises approaching banks for loans are necessarily subjected to a comprehensive risk assessment of their innovation activities by the banks. However, enterprises, out of their own interest, may choose to actively avoid disclosing R&D information to banks (Paul and David 1997). This affects the bank's overall judgment of the lending enterprise, which directly influences both the success of the loan application and the loan amount. Second, from the perspective of the stage of innovation development, prior R&D results are difficult to use as collateral for bank loans or have very low collateral value, further exacerbating the difficulty of obtaining

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external financing (Nanda and Rhodes-Kropf 2017). In summary, under the dual pressure of the banking system and enterprises themselves, the strength of financing constraint is directly related to the size of bank loans obtained, which in turn affects enterprises' R&D investment behaviour. This effect is more pronounced in SMEs (Brown et al. 2009). Based on the above analysis, the following hypothesis is proposed:

H_2: Financing constraints play a negative moderating role in the path of bank loans affecting agrifood SMEs innovation.

Finally, trade openness will increase bank loans to agrifood SMEs to provide the necessary financial support for their R&D activities. The market is the basis for the survival and development of agrifood SMEs. Besides the domestic market, openness to the outside world has also opened the foreign market. The new economic growth theory argues that trade openness is essential for technological progress and innovation. Currently, trade openness is the inevitable trend of economic globalisation, which is both an opportunity and a challenge for SMEs. The opportunity lies mainly in market expansion effects that extend enterprises' foreign markets and exposure to advanced foreign technology and experience. This facilitates an increase in the quasi-rents for exporters to innovate (Grossman and Helpman 1993) and encourages SMEs to proactively choose to innovate in order to lower their trade barriers.

The threat is mainly the effects of competition. SMEs participating in the global division of labour are bound to face fierce competition in both markets, forcing them to innovate more (Bloom et al. 2016) in order to adapt to market demands and achieve their own survival and development. This is the choice of passive innovation behaviour of SMEs. Whether it is the active or passive choice of SMEs, innovation is essential if SMEs are to survive and grow in the domestic and international markets due to competition. Innovation can provide enterprises with technological protection and differentiation strategies. In other words, trade openness increases the innovation capacity of enterprises (Bloom et al. 2016; Lei and Xie 2023; Gao and Li 2024). However, the innovation protection theory suggests that innovation is a long-term process, full of unpredictable factors, and has a high risk of failure compared to general production and business activities (Chang and Han 2022). Therefore, SMEs need stable funding to secure their innovation activities. Bank loans can be a source of funding for them. On the one hand, they can provide financing for enterprise innovation projects to purchase raw materials, equipment, and other resources. On the other hand, they can cover the salary and training costs of enterprise innovation talents. Thus, bank loans can help address the financial support for a range of innovative activities undertaken by SMEs due to trade openness needs. Based on the above analysis, the following hypothesis is proposed:

H_3: Trade openness plays a positive moderating role in the path of bank loans affecting agrifood SMEs innovation.

Based on the above analysis, Figure 1 indicates the mechanism of the impact of bank loans on agrifood SMEs innovation.

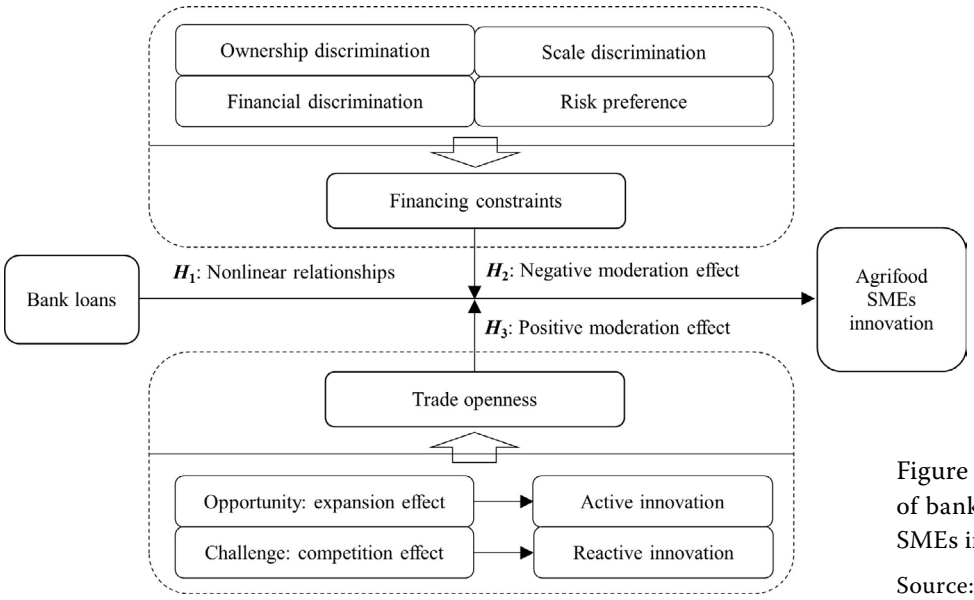

Figure 1. Theoretical mechanism of bank loans affecting agrifood SMEs innovation

Source: Authors' own elaboration

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MATERIAL AND METHODS

Data sources

The data used in this study comes from the survey conducted by the Institute of Agricultural Economics and Development, Jiangsu Academy of Agricultural Sciences, based on the National Sweet Potato Industrial Technology System Industrial Economy Fixed Observation Point Demonstration County from 2017 to 2019. The survey project has established 25 integrated pilot stations and 125 service counties across the country. The sweet potato processing SMEs investigated as the subject of this study are judged on the basis of the standard regulations for the classification of SMEs (Chinese Government website 2012). The survey method involves a one-to-one questionnaire survey of randomly selected sweet potato processing enterprises (SMEs) in the county by surveyors at fixed observation points.

The survey covers basic information about the enterprise, output information, field management, sales information, cost information, income information, quality and environmental information, raw material supply information, etc. This study is a combination of three years of survey data, a mixed cross-sectional data for this study. Compared to single-year cross-sectional data, mixed cross-sectional data provide a larger sample size and more representative sample, making the model estimates more accurate and valid (Woodridge 2002). In addition, this study has done the following with the data: *(i)* eliminated invalid questionnaires; *(ii)* eliminated samples with serious missing values and outliers for some key variables; *(iii)* performed simple arithmetic on some data. In the end, 260 valid samples were identified. The group size was 138 sweet potato processing enterprises, that is, the average number of times each sample was repeated in different periods was 1.88.

Variable descriptions

Dependent variable: enterprise innovation. Scholars measure innovation in enterprises in two main ways: inputs and outputs (Balsmeier et al. 2017; Ling and Sun 2019; Si et al. 2020). The inputs are investments in technological R&D. The output is mainly the number of patents. Given the inherent uncertainty of R&D activities, it is not always possible to achieve innovative outputs. Patents are a direct manifestation of innovation achievements and an objective reflection of an enterprise's innovation capability. Therefore, enterprise innovation in this study is represented by the natural logarithm of the total number of patents filed by enterprises in that year (Chang et al. 2015; Si et al. 2020). Considering that some enterprises have a total number of patents of zero, the natural logarithm of the total number of patents held by the enterprise in the year plus one is used as a measure (Balsmeier et al. 2017).

Core explanatory variable: bank loans. Bank loans are effectively debt financing for enterprises. This study uses the ratio of bank loans to total assets to measure the debt financing capacity of agrifood SMEs (Du and Girma 2007; Lu et al. 2012). The higher the value of this indicator, the more bank loans the enterprise has.

Control variables. Drawing on related studies (Dosi et al. 2021; Haugh et al. 2022; Luo et al. 2024; Song et al. 2024), the following control variables were selected for this study:

i) Return on assets (ROA), expressed as the ratio of operating profit to total assets, is an important indicator for assessing the profitability of an enterprise relative to the value of its total assets (Li and Chen 2021). The greater the value of ROA, the greater the profitability of the enterprise.

ii) Enterprise nature is represented by a dummy variable. If it is a private sole proprietorship, the value is assigned to 1, and otherwise, 0.

iii) Enterprise size, which is an important factor affecting the production and operation of enterprises. In this study, the number of employees of the enterprise is used to express and take the logarithmic treatment (Song et al. 2024). The higher the number of employees in the enterprise indicates the larger the enterprise size.

iv) Enterprise age, there is a certain correlation between the enterprise's innovative capacity and its establishment time, which is treated by using the current time minus the registration time and taking the logarithm of it (Song et al. 2024).

v) The age of the legal person, expressed as the actual age of the business legal person, that is, the current time minus the time of birth, and taking the logarithmic treatment of it (Luo et al. 2024). The age of the enterprise legal person has an impact on business management decisions, such as risk preference (Ye and Yao 2018), and enterprise innovation (Luo et al. 2024).

Model

The Tobit model is appropriate when the dependent variable consists of cut or fragment values (Tobin 1958; Camioto et al. 2016). The model is estimated using the great likelihood method, which can effectively avoid the bias in the estimation results of the traditional ordinary

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Table 1. Variable descriptive statistics

Variables	Mean	SD	1	2	3	4	5	6	*VIF*
1. Enterprise innovation	0.65	0.92	–	–	–	–	–	–	–
2. Bank loans	0.16	0.17	0.11	–	–	–	–	–	1.11
3. *ROA*	0.17	0.21	–0.06	–0.18	–	–	–	–	1.08
4. Enterprise nature	0.67	0.47	–0.06	0.07	0.07	–	–	–	1.06
5. Enterprise size	3.98	1.05	0.47	–0.03	–0.05	–0.15	–	–	1.30
6. Age of enterprise	1.96	0.68	0.35	0.23	–0.18	0.03	0.44	–	1.43
7. Age of the legal person	3.81	0.20	0.13	0.15	–0.18	–0.10	0.13	0.27	1.12

ROA – return on assets; *VIF* – variance inflation factor

Source: Authors' own elaboration

least squares (OLS) regression method with discrete models. As innovation in agrifood SMEs is measured by the number of patents filed by the enterprise in the current year, this indicator contains a large number of zero values, accounting for 57.31 % of the total, with obvious cut-value characteristics. Therefore, this study mainly adopted the Tobit model to explore the impact of bank loans on county agrifood SMEs innovation. The specific model is constructed as follows:

$$Lpa_{it} = \begin{cases} \alpha_0 + \alpha_1 Ba_{it} + \sum \alpha_j Con_{it} + \sum Year + \sum Area + \varepsilon_{it} \\ 0 \quad (Lpa_{it} = 0) \end{cases} \quad (Lpa_{it} > 0) \tag{1}$$

where: *Lpa* – the dependent variable; *Ba* – the core explanatory variable; *Con* – the control variable; *Year* – a year fixed effect; *Area* – a county fixed effect; ε – the random error term.

To further examine the moderating effects of financing constraints and trade openness between bank loans and enterprise innovation, the interaction terms of the moderating variables (financing constraints and trade openness) with bank loans are introduced in Equation (1). The moderating effect model is constructed as follows:

$$Lpa_{it} = \alpha_0 + \alpha_1 Ba_{it} + \alpha_2 Ba_{it} \times FT + \sum \alpha_j Con_{it} + \\ + \sum Year + \sum Area + \varepsilon_{it} s \tag{2}$$

where: *FT* – the moderating variable, including financing constraints and trade openness; *Ba* × *FT* – the interaction term between the moderating variable and bank loans.

The descriptive statistics for each variable are detailed in Table 1.

RESULTS AND DISCUSSION

The direct impact of bank loans on county agrifood SMEs innovation. Table 1 shows that the variance inflation factor *(VIF)* for each variable ranges from 1.06 to 1.43, with a mean value of 1.18, indicating that there is no multicollinearity in the model. To ensure the quality of the regression results, control variables are included in the regression, and the year and region are also controlled for. Table 2 reports the estimation results of the Tobit model. M1 in Table 2 shows that the estimated coefficient of bank loans is significantly positive. In addition, the square of bank loans (bank

Table 2. Regression estimation results of the impact of bank loans on agrifood SMEs innovation

Variables	M1
Bank loans	3.439* (1.908)
Bank loans^2	–4.296* (2.530)
Profitability	0.252 (0.837)
Enterprise nature	0.003 49 (0.258)
Enterprise size	0.573*** (0.174)
Age of enterprise	0.710** (0.329)
Age of the legal person	–0.101 (0.985)
Constant	–2.909 (4.130)
Year fixed effects	yes
County fixed effects	yes
Observations	260

*, **, and ***significance at the 10%, 5%, and 1% levels, respectively; robust standard errors for clustering to the county level are shown in brackets in the table;
SMEs – small and medium-sized enterprises

Source: Authors' own elaboration

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loans^2) is significantly negative, indicating that the marginal effect of bank loans on agrifood SMEs innovation is diminishing, with an 'inverted U-shaped' relationship. Therefore, *H1* is verified.

This may be closely related to an enterprise's debt risk tolerance. When the size of the bank loan is within the debt risk that the enterprise can control, the enterprise's ability to innovate gradually increases as the size of the loan gradually increases. When the size of bank loans exceeds the debt risk of enterprises, the larger the loan, the more severe the debt crisis faced by enterprises and the greater the disincentives to innovation. Therefore, the size of bank loans to agrifood SMEs should follow the principle of moderation. Bank loans that are too large or too small can create 'diseconomies of scale' that are detrimental to the further improvement of the innovation capacity of agrifood SMEs.

Moderating effect analysis. First, considering the role of financing constraint moderation. Financing constraints are often used to measure the availability of finance for enterprises to raise capital. At present, the main methods on the measurement of financing constraints include the KZ (Kaplan-Zingales) index and SA index. Drawing on the processing methods of Hadlock and Pierce (2010) and the completeness of the survey data, this study uses the SA index (–0.737 × enterprise size + 0.043 × enterprise size–0.04 × enterprise age) for the measurement. In the formula for calculating the SA index, enterprise size is measured as the logarithm of the total assets of the enterprise. The SA index value is negative, and as the absolute value increases, the enterprise's financing constraints also become more serious. The advantages of this method are that it does not contain endogenous financing variables, is easy to calculate, and is relatively robust (Hadlock and Pierce 2010). According to the degree of financing constraints, we use the quartile method and divide into four levels. Fc1 represents the lowest degree of financing constraint, and Fc4 represents the highest degree of financing constraint. This study takes Fc4 as the reference group and sets three dummy variables.

The interaction term between the dummy variables and bank loans is introduced on top of M1 to form M2, and the estimation results are shown in Table 3.

Table 3. Estimated results of the moderating variables

Variables	Financing constraint moderation effect	Trade openness moderation effect	Combined effect of moderating variables
	M2	M3	M4
Bank loans	10.09** (3.916)	4.862* (2.804)	8.908** (4.220)
Bank loans^2	–11.20** (5.584)	–7.784* (4.471)	–11.65** (5.814)
Bank loans × Fc1	–24.24*** (8.537)	–	–23.16*** (8.861)
Bank loans × Fc2	–3.008 (2.066)	–	–1.806 (2.148)
Bank loans × Fc3	–0.410 (3.054)	–	0.202 (3.139)
Bank loans × Trade openness	–	3.258** (1.581)	2.064 (1.430)
Constant	–1.894 (4.304)	–4.570 (5.167)	–2.009 (4.307)
Control variables	yes	yes	yes
Year fixed effects	yes	yes	yes
County fixed effects	yes	yes	yes
Observations	260	260	260

*, **, and ***significance at the 10%, 5%, and 1% levels, respectively; robust standard errors for clustering to the county level are shown in brackets in the table

Source: Authors' own elaboration

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There is still a significant positive effect of bank loans on agrifood SMEs innovation after the inclusion of the moderating variable of financing constraints. M2 shows that the coefficient on the interaction term between bank loans and the three financing constraint dummy variables is negative, and the coefficient decreases as the intensity of the financing constraint increases. However, only the coefficient on 'Bank loans × Fc1' is significant. This suggests that agrifood SMEs with weak financing constraints have more bank loans than agrifood SMEs with strong financing constraints and have a slight advantage in enhancing their innovation capacity. This finding is consistent with expectations and verifies *H2*. The degree of financing constraints of agrifood SMEs has a direct impact on the size of their bank loans, and thus on their own innovation capacity. From this perspective, improving the financing constraint environment would be an important breakthrough in moderating the increased innovation capacity of agrifood SMEs.

Second, considering the role of trade openness moderation. This study measures the trade openness of agrifood SMEs using the behaviour of whether they choose to export or not (Cao 2015). It takes a value of 1 if the firm exports in the current year; otherwise, 0. M3 in Table 3 reports the moderating effect of trade openness on the relationship between bank loans and agrifood SMEs innovation. The results show that there is still a significant positive effect of bank loans on agrifood SMEs innovation after including the moderating variable of trade openness. From M3, the estimated coefficient of the interaction term between bank loans and trade openness is significantly positive, indicating that trade openness plays a positive moderating role in the path of bank loans affecting agrifood SMEs innovation. This is consistent with the expected findings and verifies *H3*. Agrifood SMEs that have opted for open trade to participate in the international division of labour and cooperation must produce in strict accordance with international production technology standards in order to reduce trade barriers and stimulate their demand for innovation. In fact, bank loans can provide financial support for a range of innovative activities undertaken by agrifood SMEs as a result of their trade needs. However, the size of bank loans of agrifood SMEs requires adherence to the principle of moderation. Therefore, promoting trade openness can be an important springboard for agrifood SMEs to improve their innovation capacity.

Third, considering the combined effect of moderating variables. M4 in Table 3 reports parameter estimates that consider the effects of both the financing constraint and trade openness moderating variables. The results show that the cross term between trade openness and bank loans is not significant in the Tobit model estimates under the combined effect of the two moderating variables. Among the three dummy variables for financing constraints, only 'Bank loans × Fc1' has a significant effect on agrifood SMEs innovation. This suggests that agrifood SMEs with weak financing constraints are the most innovative when the combined effect of moderating variables is considered. It is worth noting that the estimated coefficients for the two moderating variables have similar characteristics to those described above, differing only in their significance and the strength of their effects. In summary, the overall combined estimated effect shows that bank loans still have a significant positive impact on agrifood SMEs innovation. However, the size of bank loans of agrifood SMEs requires adherence to the principle of moderation. The findings of the study are consistent with the previous section.

Robustness tests. First, the endogeneity test. There may be a reciprocal causal relationship between bank loans and agrifood SMEs innovation. In order to reduce the bias in the estimation of the model due to endogeneity issues, the county level of savings and loans *(Csl)* is chosen as the instrumental variable. The *Csl* is expressed as the ratio of total bank savings and loans at the end of the year to total bank savings and loans nationally.

A statistical test of the instrumental variables for M5 and M6 showed that the Anderson-LM statistic was 4.369 and 4.904 respectively, with *P*-values of 0.037 and 0.027 respectively, strongly rejecting the original hypothesis that the instrumental variables were underidentified at the 5% level of significance. Therefore, this study argues that the instrumental variable is valid and the estimated results will be robust. Table 4 shows the results of the 2SLS estimation. In the first stage, the estimation results of both M5 and M6 show that the level of savings and loans is significantly positive with bank loans to agrifood SMEs, indicating that the instrumental variables have a positive relationship with enterprise bank savings and satisfy the correlation hypothesis. In the second stage, the estimated results for both M5 and M6 show a significantly positive estimated coefficient for bank loans, indicating that it has a significant contribution to innovation in agrifood SMEs. From Bank loans^2, the size of the enterprise's loans requires adherence to the principle of moderation. Therefore, the conclusion still holds after considering the endogeneity issue.

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Table 4. Results of robustness tests for endogeneity issues

Variables	OLS		IV-Tobit	
	M5		M6	
	First stage bank loans	Second stage enterprise innovation	First stage bank loans	Second stage enterprise innovation
Bank loans	–	11.49** (5.721)	–	32.23* (18.95)
Csl	0.481* (0.253)	–	0.481** (0.242)	–
Bank loans^2	1.300*** (0.108)	–14.43* (7.946)	1.300*** (0.046)	–41.05* (24.76)
Bank loans × Fc1	0.274** (0.117)	–3.798 (2.370)	0.274*** (0.046)	–15.84*** (6.034)
Bank loans × Fc2	0.262*** (0.066 4)	–3.122** (1.529)	0.262*** (0.046)	–7.997 (5.288)
Bank loans × Fc3	0.341*** (0.039 0)	–2.026 (2.012)	0.341*** (0.050)	–8.384 (6.767)
Constant	–0.089 1 (0.060 6)	0.508 (1.066)	–0.089 (0.077)	0.819 (3.565)
Control variables	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
County fixed effects	yes	yes	yes	yes
Observations	260	260	260	260

*, **, and ***significance at the 10%, 5%, and 1% levels, respectively; robust standard errors for clustering to the county level are shown in brackets in the table; *Csl* – county level of savings and loans; IV –instrumental variables; OLS – ordinary least square

Source: Authors' own elaboration

Second, substitution of dependent variable test. To further ensure the robustness of the findings, this study uses the ratio of technology R&D investment to operating income as a new indicator to measure innovation in agrifood SMEs from the perspective of innovation investment (Adhikari and Agrawal 2016). In addition, the OLS method (M7) and Tobit model (M8) were used to regress the results separately and are shown in Table 5. The estimated coefficients for bank loans are all significantly positive, indicating a positive effect on innovation in agrifood SMEs. From Bank loans^2, the size of the enterprise's loans requires adherence to the principle of moderation. This conclusion is consistent with the results of the above study.

Table 5. Results of robustness tests for the substitution dependent variable

Variables	OLS	Tobit
	M7	M8
Bank loans	2.169** (1.054)	2.166* (1.275)
Bank loans^2	–2.911** (1.388)	–2.846* (1.710)
Bank loans × Fc1	–1.968** (0.824)	–2.291** (1.149)
Bank loans × Fc2	–3.071*** (0.857)	–3.438*** (0.803)
Bank loans × Fc3	–3.474*** (0.885)	–3.592*** (0.642)
Constant	4.488*** (1.534)	4.569** (1.791)
Control variables	yes	yes
Year fixed effects	yes	yes
County fixed effects	yes	yes
Observations	260	260

*, **, and ***significance at the 10%, 5%, and 1% levels, respectively; robust standard errors for clustering to the county level are shown in brackets in the table; OLS – ordinary least squares

Source: Authors' own elaboration

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Table 6. Results of the sample selection bias test

Variables	Probit	OLS	Tobit
	M9	M10	M11
Bank loans	2.709* (1.594)	4.383*** (0.954)	4.383*** (0.908)
Bank loans^2	–3.036 (2.152)	–5.312*** (1.022)	–5.312*** (0.972)
Invmillsss	–	1.319*** (0.239)	1.319*** (0.227)
Constant	–1.656 (3.187)	–3.524* (1.910)	–3.524* (1.818)
Control variables	yes	yes	yes
Year fixed effects	yes	yes	yes
County fixed effects	yes	yes	yes
Observations	244	244	244

*, **, and ***significance at the 10%, 5%, and 1% levels, respectively; robust standard errors for clustering to the county level are shown in brackets in the table; OLS – ordinary least squares; Invmillss – inverse mills

Source: Authors' own elaboration

Third, sample selection bias test. To mitigate the bias in estimation results caused by sample selection bias, this study applied the Heckman two-stage model. In the first stage, the important variables affecting innovation in agrifood SMEs, such as bank loans, Bank loans^2, and the control variables above, were selected to regress a Probit model on whether the agrifood SMEs were successful in their innovation (whether they applied for the patent). The estimation results are detailed in M9 (Table 6). In the second stage, the obtained inverse mills ratio (invmillsss) was re-estimated by incorporating them into the original model, and the results are shown in M10 and M11. It can be seen that the coefficient of invmillsss is significantly positive, the sample is subject to selection bias, and a Heckman two-stage estimation method is required. The estimated results show that the estimated coefficient for bank loans is still significantly positive, again verifying that bank loans have a positive effect on innovation in county agrifood SMEs. From Bank loans^2, the size of the enterprise's loans requires adherence to the principle of moderation. This conclusion is consistent with the results of the above study.

CONCLUSION

This study explores the relationship between bank loans and county SMEs innovation based on mixed cross section data of county sweet potato processing enterprises, using the Tobit model. The results of the study show that bank loans have a positive effect on county agrifood SMEs innovation. On this basis, further analysis reveals that there is an 'inverted U-shaped' relationship between bank loans and county agrifood SMEs innovation. The moderating effect test found that financing constraints play a negative moderating role in the pathway by which bank loans affect innovation in agrifood SMEs. Trade openness plays a positive moderating role in the pathway by which bank loans affect innovation in agrifood SMEs. Under the combined effect of the moderating variables, bank loans were found to be more significant in promoting innovation in agrifood SMEs in counties with weak financing constraints and high trade openness.

In order to further promote innovation in county agrifood SMEs in China, the following insights are gained based on the above study findings. First, strengthen the support of agrifood SMEs' financing policies. Local governments and financial institutions can promote the spirit of service by lowering the financing threshold for bank loans for county agrifood SMEs and providing a stable source of funding for their innovative activities. Second, the size of bank loans of agrifood SMEs should adhere to the principle of moderation. If enterprises loans are too large, they may suffer a debt crisis and inhibit the development of their innovative capacity. If conservative decisions are taken, the size of the loans may be too small to achieve an optimal allocation of innovation resources. Therefore, the size of the enterprise's bank loans should match its ability to repay its debts. Third, rely on the combined efforts of the government and the market to improve China's financial system, especially the construction of the county banking system. This provides the financial basis for alleviating bank loan constraints for agrifood SMEs in China's counties and helping to transform county economies.

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Finally, improve the county SMEs trade policy system. Local governments should adopt policies to encourage and support county agrifood SMEs to engage in foreign trade and actively participate in the international division of labour and cooperation. This initiative can make full use of the openness dividend to learn from advanced foreign technologies, improve their innovation capacity, and enable SMEs to 'overtake' during the economic transformation period.

The limitations of this study are as follows. First, the survey data of this study mainly comes from sweet potato processing enterprises and has not yet included the processing data of other crops, which may differ due to the differences in crop attributes. In the future, consideration can be given to expanding the types of enterprises to enrich studies in this area. Second, the amount of data in this study was limited due to the geographical and financial constraints of the survey, which led to a limited sample for tracking. Therefore, the advantage of the fixed observation point of the industrial economy of the National Sweet Potato Industrial Technology System can be fully utilised in future studies to expand the research sample size and continuous tracking studies. Finally, due to the limitations of the research data, it was not possible to further explore the relationship between bank loans and innovation in agrifood SMEs at different stages of development based on the life cycle of the enterprise.

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REFERENCES

Adegboye A.C., Iweriebor S. (2018): Does access to finance enhance SME innovation and productivity in Nigeria? Evidence from the World Bank Enterprise Survey. African Development Review, 30: 449–461.

Adhikari B.K., Agrawal A. (2016): Religion, gambling attitudes and corporate innovation. Journal of Corporate Finance, 37: 229–248.

Aiello F., Bonanno G., Rossi S.P. (2020): How firms finance innovation. Further empirics from European SMEs. Metroeconomica, 71: 689–714.

Allen F., Qian J., Qian M.J. (2005): Law, finance, and economic growth in China. Journal of Financial Economics, 77: 57–116.

Arrow K.J. (1972): Economic welfare and the allocation of resources for invention. In: Rowley C.K. (ed): Readings in Industrial Economics. London, Palgrave: 219–236.

Bakhouche A. (2022): Assessing the innovation-finance nexus for SMEs: Evidence from the Arab Region (MENA). Journal of the Knowledge Economy, 13: 1875–1895.

Balsmeier B., Fleming L., Manso G. (2017): Independent boards and innovation. Journal of Financial Economics, 123: 536–557.

Banerjee A.V., Duflo E. (2010): Giving credit where it is due. Journal of Economic Perspectives, 24: 61–80.

Bartoloni E. (2013): Capital structure and innovation: Causality and determinants. Empirica, 40: 111–151.

Belas J., Rahman A., Rahman M.T., Schonfeld J. (2017): Financial constraints on innovative SMEs: Empirical evidence from the Visegrad countries. Engineering Economics, 28: 552–563.

Benfratello L., Schiantarelli F., Sembenelli A. (2008): Banks and innovation: Microeconometric evidence on Italian firms. Journal of Financial Economics, 90: 197–217.

Berger A.N., Udell C.F. (2002): Small business credit availability and relationship lending: The importance of bank organisational structure. The Economic Journal, 112: 32–53.

Bloom N., Draca M., Reenen J.V. (2016): Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity. The Review of Economic Studies, 83: 87–117.

Brown J.R., Fazzari S.M., Petersen B.C. (2009): Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. Journal of Finance, 64: 151–185.

Bu Y., Du X., Wang Y., Liu S., Tang M., Li H. (2024): Digital inclusive finance: A lever for SME financing? International Review of Financial Analysis, 93: 103115.

Cai D., Shen H., Liu B. (2016): Identifying the influence of institutional factors on the R&D activities of Chinese SMEs. Innovation, 18: 54–73.

Cao C. (2015): 'Export self–selection effect' of industrial enterprises in China: An empirical analysis based on new-new trade theory. Journal of International Trade, 2015: 108–121. (in Chinese)

Camioto F.D., Moralles H.F., Mariano E.B., Rebelatto D.A.D. (2016): Energy efficiency analysis of G7 and BRICS considering total-factor structure. Journal of Cleaner Production, 122: 67–77.

Chang X., Fu K.K., Low A., Zhang W.R. (2015): Non-executive employee stock options and corporate innovation. Journal of Financial Economics, 115: 168–188.

Chang R., Han B.S. (2022): (How excess cash influences enterprises' R&D input—Empirical research based on enterprise heterogeneity and influencing mechanism). Research on Economics and Management, 2022: 126–144. (in Chinese)

Chiappini R., Montmartin B., Pommet S., Demaria S. (2022): Can direct innovation subsidies relax SMEs' financial constraints? Research Policy, 51: 104493.

https://doi.org/10.17221/324/2024-AGRICECON

Chinese Government Website (2012): Notice on the Issuance of the Standard Provisions for the Classification of Small and Medium-sized Enterprises. Available at http://www.gov.cn/gongbao/content/2012/content_2041870.htm (accessed Sept 2, 2022).

Chinese Government Website (2022): 2.7-fold Increase in 10 Years, Quality and Efficiency Rising – Number of Small and Medium-Sized Enterprises Reaches 48 Million Nationwide. Available at http://www.gov.cn/xinwen/2022-09/02/content_5707953.htm (accessed Sept 2, 2022).

Claessens S., Laeven L. (2003): What drives bank competition? Some international evidence. Journal of Money, Credit, and Banking, 36: 563–583.

Czarnitzki D., Hottenrott H. (2011): R&D investment and financing constraints of small and medium-sized firms. Small Business Economics, 36: 65–83.

Damanpour F., Gopalakrishnan S. (2001): The dynamics of the adoption of product and process innovations in organizations. Journal of Management Studies, 38: 45–65.

Diamond D.W. (1984): Financial intermediation and delegated monitoring. The Review of Economic Studies, 51: 393–414.

Dosi G. (1982): Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technological change. Research Policy, 11: 147–162.

Dosi G., Piva M., Virgillito M.E., Vivarelli M. (2021): Embodied and disembodied technological change: The sectoral patterns of job-creation and job-destruction. Research Policy, 50: 104199.

Du J., Girma S. (2007): Finance and firm export in China. Kyklos, 60: 37–54.

Gao S., Li Z. (2024): Trade policy uncertainty, financing constraints, and firm innovation: Evidence from China. Journal of the Knowledge Economy, 16: 8929–8960.

Grossman G.M., Helpman E. (1993): Innovation and Growth in the Global Economy. Cambridge, MIT Pres: 85–86.

Guercio M.B., Martinez L.B., Bariviera A.F., Scherger V. (2020): Credit crunch or loan demand shortage: What is the problem with the SMEs' financing? Czech Journal of Economics and Finance, 70: 521–540.

Hadlock C.J., Pierce J.R. (2010): New evidence on measuring financial constraints: Moving beyond the KZ index. Review of Financial Studies, 23: 1909–1940.

Hall B.H., Lerner J. (2010): The financing of R&D and innovation. In: Hall B.H., Rosenberg N.: Handbook of the Economics of Innovation, Vol. 1. Amsterdam, North-Holland: 609–639.

Harrison R., Li Y., Vigne S.A., Wu Y. (2022): Why do small businesses have difficulty in accessing bank financing? International Review of Financial Analysis, 84: 102352.

Haruna A., Oumbé H.T., Kountchou A.M., Kakeu C.B.P. (2024): Can Islamic finance enhance the innovation capacity of Cameroonian SMEs? Empirical evidence based on a multivariate probit approach. Borsa Istanbul Review, 24: 187–200.

Haugh H., Robson P., Hagedoorn J., Sugar K. (2022): The nascent ecology of social enterprise. Small Business Economics, 58: 1223–1242.

He Y., Chen L.L., Du Y.G. (2024): (Does data assetization alleviate financing constraints of SRDI SMEs). China Industrial Economics, 2024: 154–173. (in Chinese)

Hu D., Fang X., DiGiovanni Y.M. (2023): Technological progress, financial constrains, and digital financial inclusion. Small Business Economics, 61: 1693–1721.

Hu B., Onwachukwu C.I., Yan I.K.M., Zhang W., Shang S. (2024): Assessing the impact of financing on SMEs' innovation in China. Review of Development Economics, 29: 1546–1568.

Ivanová E. (2017): Barriers to the development of SMEs in the Slovak Republic. Oeconomia Copernicana, 8: 255–272.

Kärnä A., Manduchi A., Stephan A. (2021): Distance still matters: Local bank closures and credit availability. International Review of Finance, 21: 1503–1510.

Krusell P., Ríos-Rull J.V. (1996): Vested interests in a positive theory of stagnation and growth. The Review of Economic Studies, 63: 301–329.

Lei T., Xie P. (2023): Fostering enterprise innovation: The impact of China's pilot free trade zones. Journal of the Knowledge Economy, 15: 10412–10441.

Li J., Chen S.L. (2021): (The Impact of Urban Economic Coordination Committee on innovation: Evidence form Quasi-natural experiment). Nankai Economic Studies, 2021: 102–121. (in Chinese)

Li L., Lin Q., Wang X. (2024): Internal drive or external pull: Independent innovation and sustainable growth of Chinese agricultural enterprises. Foods, 13: 3185.

Lin Y.F., Li Y.J. (2001): (Promoting the growth of medium and small-sized enterprises through the development of medium and small-sized financial institutions). Economic Research Journal, 2001: 10–18+53–93. (in Chinese)

Ling H.C., Sun Y.L. (2019): (Can social trust improve corporate innovation ability?) Studies in Science of Science, 2019: 1912–1920. (in Chinese)

Lou Z., Xie Q., Shen J.H., Lee C.C. (2024): Does supply chain finance (SCF) alleviate funding constraints of SMEs? Evidence from China. Research in International Business and Finance, 67: 102157.

Lu Z.F., Zhu J.G., Zhang W.N. (2012): Bank discrimination, holding bank ownership, and economic consequences: Evidence from China. Journal of Banking and Finance, 36: 341–354.

Luo L.H., Wang Y., Qian L. (2024): (Does entering national high-tech zone improve the development quality of scientific and technological enterprises?) Journal of Macro-Quality Research, 12: 72–85. (in Chinese)

https://doi.org/10.17221/324/2024-AGRICECON

Marti J., Quas A. (2018): A beacon in the night: government certification of SMEs towards banks. Small Business Economics, 50: 397–413.

McCarthy S., Oliver B., Verreynne M.L. (2017): Bank financing and credit rationing of Australian SMEs. Australian Journal of Management, 42: 58–85.

Murphy K.M., Shleifer A., Vishny R.W. (1993): Why is rent-seeking so costly to growth? The American Economic Review, 83: 409–414.

Nanda R., Rhodes-Kropf M. (2017): Financing risk and innovation. Management Science, 63: 901–918.

Nelson R., Winter S. (1982): An Evolutionary Theory of Economic Change. Cambridge, Harvard University Press: 129–137.

O'Brien J. (2003): The capital structure implication of pursuing a strategy of innovation. Strategic Management Journal, 24: 415–431.

Palmieri E., Ferilli G.B. (2024): Innovating the bank-firm relationship: A spherical fuzzy approach to SME funding. European Journal of Innovation Management, 27: 487–515.

Paul W., David J.S. (1997): Financial constraints on the growth of high technology small firms in the United Kingdom. Applied Financial Economics, 7: 197–201.

Pingliang Bureau of Industry and Information Technology (2023): Improving the Business Environment for SMEs and Ensuring their Fair Participation in Market Competition. Available at http://gxj.pingliang.gov.cn/xwdt/gxgz/art/2023/art_7ebb2812b6d340fdbe6ab8a287129df0.html (accessed Jan 11, 2023).

Rajan R.G. (1992): Insiders and outsiders: The choice between informed and arm's-length debt. The Journal of Finance, 47: 1367–1400.

Si D.K., Wang Y.N., Kong D.M. (2020): Employee incentives and energy firms' innovation: Evidence from China. Energy, 212: 118673.

Song H., Yang X., Yu K. (2020): How do supply chain network and SMEs' operational capabilities enhance working capital financing? An integrative signaling view. International Journal of Production Economics, 220: 107447.

Song G.H., Dong Y.D., Ding C.L. (2024): (Can the development of public service industry promote the export sophistication of enterprises). International Business, 2024: 39–55. (in Chinese)

Spatareanu M., Manole V., Kabiri A. (2019): Do bank liquidity shocks hamper firms' innovation? International Journal of Industrial Organization, 67: 102520.

Strahan P.E., Weston J.P. (1998): Small business lending and the changing structure of the banking industry. Journal of Banking and Finance, 22: 821–845.

Tian Y., Su Q. (2024): Digital transformation, information and lending distance – Evidence from Chinese bank branch data. Economic Analysis and Policy, 84: 545–560.

Tobin J. (1958): Estimation of relationships for limited dependent variables. Econometrica: Journal of the Econometric Society, 26: 24–36.

Wang X.C. (2002): (Capital-structural condition of firm's decision on innovative investment). China Industrial Economics, 2002: 89–95. (in Chinese)

Wang G.G., Xie F.J., Jia Y. (2017): (Reconsider incentive mechanism of R&D subsidy policy – Based on exploration for external financing incentive mechanism). China Industrial Economics, 2017: 60–78. (in Chinese)

Wang Z., Zhao Q., Zong X. (2022): Financial constraints with the outbreak of COVID-19 and the equity guarantee swap. Emerging Markets Finance and Trade, 58: 82–92.

Woodridge J.M. (2002): Econometric Analysis of Cross Section and Panel Data. Cambridge, The MIT Press: 380–394.

Xiang D., Zhang Y., Worthington A.C. (2021): Determinants of the use of fintech finance among Chinese small and medium-sized enterprises. In: 2018 IEEE International Symposium on Innovation and Entrepreneurship. Beijing, Mar 30–Apr 1, 2018.

Xiao S., Zhao S. (2012): Financial development, government ownership of banks and firm innovation. Journal of International Money and Finance, 31: 880–906.

Xin F., Zhang J., Guo Y., Liang S. (2022): Banking structure change and corporate innovation: Evidence from Chinese city-branch data. Accounting & Finance, 62: 2057–2084.

Xue L., Luo F., Huang R.L. (2016): (The autonomous innovation effect of bank credit in the new normal: Empirical evidence and realization mechanisms). Jianghai Academic Journal, 2016: 220–226. (in Chinese)

Yao D., Ding R., Chen J., Liao Y. (2024): Bridging the financing gap for unlisted science and technology-based SMEs in China: A comprehensive evaluation framework. Journal of the Knowledge Economy, 15: 18531–18589.

Ye X.T., Yao L.X. (2018): (On the priority and influencing factors in the demand of small and micro e-commerce startups for policy support). Contemporary Finance & Economics, 2018: 102–112. (in Chinese)

Yu J., Peng F., Shi X., Yang L. (2022): Impact of credit guarantee on firm performance: Evidence from China's SMEs. Economic Analysis and Policy, 75: 624–636.

Zhang L. (2022): Bank competition, financing constraints, and enterprise innovation investment. Discrete Dynamics in Nature and Society, 2022: 7399321.

Zhou W. (2013): Political connections and entrepreneurial investment: Evidence from China's transition economy. Journal of Business Venturing, 28: 299–315.

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