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Impact of Technological Innovation on SMEs' Bank Loans: Moderating Effect of Bank-enterprise Relationship

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***Abstract*—This paper explores the impact of technological innovation on SMEs' loan structure under the moderating effect of the bank-enterprise relationship length as a condition variable. OLS model was established and 487 technological enterprises in Guangdong province were selected. Results show: first, R&D investment, the number of applied patents and authorized patents all affect loan structure negatively; second, when the relationship length becomes longer, technological innovation has positive effect on loan structure. Particularly, the number of authorized patents can effectively raise loan rates, reduce costs and increase long-term loans. On the contrary, the shorter the relationship length is, the faster the loan structure deteriorates; third, under the intervention of relationship length, the pecking order of promoting effect of three technological innovation variables on loans is as follows: authorized patents, applied patents and R&D investment.**

Keywords—technological innovation; bank-enterprise relationship; loan structure

I. INTRODUCTION

It is difficult for Chinese SEMs to get bank loans because of technological innovation as a whole. Therefore, Innovative SMEs actively develop relational financing and solve the problem of bank loans through informal and non-institutional channels. However, no previous research has investigated such problems in China. This paper aims to solve the problem how to improve the SMEs' financing difficulties when technological innovation generally affects bank loans negatively.

Some studies consider that technological innovation has a negative effect on bank loans. Hyytinen and Pajarinen (2005) found that R&D investment reduced the lending capacity of banks in small enterprises. When innovative projects have financing needs, enterprises will reduce debt financing needs. Hence, the more the technological innovation activities are, the more unfavorable bank loans will be. However, some researches obtained a completely different conclusion. The research of Zhang et al. (2013) on Chinese high-tech enterprises presented that the stronger the technical innovation ability, the lower the risk of bank loans. Studies by Wang and Thornhill (2010) suggested that enterprises prefer relational debt at moderate R&D investment points. These provide a hint to relevant studies, that is, there may be a balance point between technological innovation and relational financing. The more in-depth the technological innovation activities are, the harder it will be to obtain bank loans, because the increase of innovation activities leads to greater risk. Widely accepted, information asymmetry exists between innovation enterprises and banks or other creditors. It is precisely because of it that leads to "sparing loan".

Many scholars attempt to deal with the problem from the angle of bank-enterprise relationship and relational financing, and tested that it can be solved better. Charumilind et al. (2006) argued that the bank-enterprise relationship can promote bank loans, even long-term loans, and reduce mortgage or costs. It can overcome the limitation of credit limit, loan approval process constraints in the relatively single relationship, and improve loan issuance rate. Meanwhile, more financing services have made it easier for enterprises to obtain loans. The above researches indicate that the better the bank-enterprise relationship, the better the effect of SMEs' loans.

Herrera and Minetti (2007) highlighted that relational banks would not interfere too much in the assessment and development stage of technological innovation, and could provide more funds for new technologies. Generally, banks are "reluctant to lend" when enterprises are carrying out technological innovation activities. But because of relational banks, enterprises may be supported by loans. It confirmed the importance of bank-enterprise relationship.

According to the literature analysis, this paper argues that the negative effects of bank loans caused by previous technical innovation may disappear and turn into positive results due to the cooperative relationship. The effect of technological innovation on SMEs' bank loans changes with the intervention of relationship length. Namely, the longer the bank-enterprise cooperative relationship is, the more technical innovation will optimize the loan structure. This paper attempts to prove this expected conclusion.

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II. RESEARCH DESIGN

A. Sample Selection

The data consisted of two parts: one was the enterprises listed on the Shenzhen Stock Exchange SMEs Board exchange by March 2018, and the other was obtained by questionnaires and interviews. Some unsuitable samples were removed: (1) financial companies. (2) ST and PT enterprises. (3) enterprises with data anomalies and missing. (4) pure foreign-funded enterprises. In addition, we examined the section data without considering the merger and reorganization of sample enterprises, or the transfer of control rights.

Questionnaires were conducted in two phases. The first phase was conducted from the beginning of March 2016 to the end of September 2016. Through our social network relationships, 214 questionnaires were obtained by field visits, questionnaires and e-mails to technological SMEs in Guangdong province. Eventually, 202 questionnaires were valid except 12 enterprises that had never received loans. The second phase aimed at expanding the sample size, and was conducted from July 2017 to December 2017. After re-investigating those enterprises in the first phase, another 400 questionnaires were added, and 304 valid questionnaires were recovered, and 285 of them were left after excluding those enterprises that had never received loans. The final data obtained included the bank-enterprise relationship length, finance, basic information, R&D investment and patent number variables of the sample enterprises. The participants in both phases were business owners or middle and senior managers. According to statistics results, a total of 487 valid questionnaires were obtained. The R&D and patent data came from Guangzhou Strategic Point Market Research Co., Ltd., China intellectual property network patent retrieval database, questionnaire survey and interview. On the other hand, the comprehensive financial data came from CSMAR database, South China Institute of Medical and Economics by questionnaires and interviews.

B. Variable Setting

1) Explained variables: Bank loan rate (Rate), loan cost (Cost) and loan term (Term) were taken to reflect SMEs' loan structure. The ratio of total loans and total debt were used to measure Rate, the rate of interest expenses and total loans were employed to measure Cost, and the rate of long-term loans and total loans were chosen to measure Term.

2) Explaining variables: Three variables, R&D investment (R&D), patent number (Lnapt) and authorized patent number (Lngpt), were adopted to reflect SMEs' technological innovation level. As to the assignment of variables, due to the large difference between R&D input and patent output in innovation, some enterprises even have no input or output at all, that is, the R&D input and patent number are distributed in the right-deviation state. In order to solve the problem that the value on the right is zero, this paper adopted the method of Rossi (2005) to add 1 to the R&D investment, the number of applied patents and the number of authorized patents, and then took the logarithm.

3) Conditional variables: "Relationship Length" was applied to measure the bank-enterprise relationship. The relationship length is the number of years of the establishment of enterprise-bank cooperative relations.

Control variables (X). We controlled Age, Industry, Ownership, Size, Capital, Growth, Profit, Debt, Loyalty, Brand and Audit variables.

III. EMPIRICAL ANALYSIS

OLS model was constructed to demonstrate the relationship between SMEs' technical innovation level and loan structure of banks, as shown in equation (1):

$$Loan = \alpha + \beta_1 \ln(1 + R\&D) + \beta_2 \ln(1 + Lnapt) + \beta_2 \ln(1 + Lngpt) + \sum \gamma_n X + \varepsilon_i \quad (1)$$

Among them, i is the number of the tested enterprises, α is the constant term, $\beta_1, \beta_2, \beta_3, \gamma_n$ respectively represents R&D investment, the number of applied patents, the number of authorized patents, and the coefficients of control variables, n, X respectively explains the number and symbol of control variables, and ε_i is the error term.

Firstly, the correlation analysis of all explanatory variables in equation (1) was carried out in SPSS17.0, and it was only found that Age and Loyalty were significantly positively correlated at a lower level. This clarifies that the more the years of the tested enterprises, the better the credit degree of enterprises. Additionally, the correlation coefficient between variables is little basically, the correlation between explanatory variables in the model is weak, which indicates that there is no multi-collinearity in explanatory variables. In the process of regression, White heteroscedasticity correction technology was used to eliminate the possible heteroscedasticity problems in the model.

A. Effects of Technological Innovation on Loan Structure

Regression analysis of equation (1) was carried out in Stata 12.0 software, as demonstrated in "Table I".

TABLE I. EFFECTS OF TECHNICAL INNOVATION ON LOAN STRUCTURE

	Rate	Cost	Term
Intercept	0.298*** (0.775)	0.193** (0.810)	0.181** (0.913)
Ln(1+R&D)	−0.135*** (−1.252)	0.251*** (1.417)	−0.084*** (−0.883)
Ln(1+Lnapt)	−0.050*** (0.108)	0.081* (0.149)	−0.069** (0.221)
Ln(1+Lngpt)	−0.072* (0.775)	0.102* (0.438)	−0.098* (0.912)
Observations	487	487	487
Adj. R2	0.161	0.111	0.102
F Value	11.056***	9.001***	7.348***

[a.] Note: *, ** and *** respectively indicates that the statistics are significant at 10%, 5% and 1% levels, and the standard error are in brackets.

"Table I" illustrates that R&D has significant negative, positive and negative correlation with loan rate, loan cost and loan term at the level of 0.01 respectively. It means that the more the R&D investment, the fewer bank loans and the less long-term loans, but the more the loan costs. The fundamental reason is that the increased R&D investment leads to the increased risk of enterprises' innovation, which makes banks hesitate to issue loans. The number of applied patents and authorized patents are both significant to the regression results of the three loan structure variables, and the regression coefficients are negative, positive and negative respectively, which are the same with the symbol of the regression coefficient of R&D, indicating that the more patent output, the more unfavorable to its bank loans. Meanwhile, the significance level of R&D and applied patents are generally larger than that of authorized patents, suggesting that the number of authorized patents has a relatively less negative effect on bank loans. In summary, we argue that the increase of SMEs' technological innovation activities has a significant negative effect on bank loans, which is in line with the main viewpoints of relevant academic studies.

B. Effects of Technological Innovation on Loan Structure Under the Grouping of Relationship Length

According to the survey results, 94.69% of the sample enterprises have established bank-enterprise cooperation relationship. The relationship length is grouped, and we set the data larger than the median into group A, and the rest into group B. The regression of model (1) continues and the results are shown in "Table II".

TABLE II. EFFECTS OF TECHNOLOGICAL INNOVATION ON LOAN STRUCTURE (GROUPED BY RELATIONSHIP LENGTH)

	Rate		**Cost**		**Term**	
	Group A	***Group B***	***Group A***	***Group B***	***Group A***	***Group B***
Intercept	0.274* (0.612)	0.245** (0.537)	0.221* (0.688)	0.193** (0.604)	0.186* (0.713)	0.137*** (0.485)
Ln(1+R&D)	0.215 (0.560)	−0.168*** (−0.574)	−0.103* (−0.419)	0.197*** (0.660)	0.084* (0.699)	−0.134*** (−0.718)
Ln(1+Lnapt)	0.114* (0.384)	−0.190** (−0.421)	−0.136* (−0.257)	0.114** (0.329)	0.166* (0.318)	−0.067** (−0.126)
Ln(1+Lngpt)	0.107** (0.343)	−0.199** (−0.500)	−0.112** (−0.397)	0.086** (0.216)	0.111** (0.481)	−0.095*** (−0.092)
Observations	172	315	172	315	172	315
Adj. R^2	0.128	0.202	0.107	0.195	0.080	0.189
F Value	10.015***	13.100***	8.813***	11.884***	7.121***	11.430***

"Table II" reveals that: (1) Vertical comparison. The regression coefficient symbol of group A is exactly opposite to that of group B, and most of the regression results of group A are significantly correlated at the level of 0.1 even above (except for R&D investment). This unearths that when the relationship length is significantly increased, the negative effect of technological innovation on loan structure becomes not obvious, but almost positively affected by relationship length. That is to say, when the enterprise-bank cooperative relationship reaches a certain period of time, the amount of information exchange between banks and enterprises increase greatly. Hence, the phenomenon of information asymmetry decreases greatly, and the "reluctant to lend" due to innovation risk and the uncertainty of market prospect is also greatly reduced. As a result, the tested enterprises can obtain better loans and long-term loans and less loan cost. By contrast, all regression results of group B are significantly correlated at the level of 0.05. Compared with "Table I", it proved that when the relationship length is little to a certain extent, the negative impact of technological innovation may become stronger. (2) Horizontal comparison. In Group A, the significance level of R&D and applied patents are significantly lower than that of authorized patents, indicating that in the innovation environment with a long relationship length, the number of authorized patents plays the most significant role in optimizing the loan structure. However, the significance level of R&D in group B is relatively stronger than that of the two patent variables. That is to say, in the innovation environment with a little relationship length, R&D investment has the strongest negative effect on loan structure. As shown in "Table II", the reason for this result is that among the three innovation variables, R&D investment is the most uncertain and risky, and the number of patents granted and the market predictability are relatively good. Banks naturally give the former lower credit ratings when evaluating loans.

C. Robustness Test

The data of three technological innovation variables were delayed for one period, namely 202 sets of sample data in 2015 were adopted, while the data of other variables in 2016 were selected after re-investigation. Then, the regression was conducted by order as shown in "Table I" and "Table II", and the results of the two rounds of regression were compared with the above tables one by one. It was found that the significance of some variables in the robustness analysis results decreased, which may be caused by the reduction of sample size in the robustness test. However, most of them are consistent from the viewpoint of regression coefficient symbol and significance. Only a few places have changed from significant to insignificant. On the whole, the regression analysis results of this paper have good stability.

IV. CONCLUSION

The main conclusions are as follows: technical innovation has a significant negative effect on SMEs' loan structure. However, with the intervention of the bank-enterprise relationship for a long period of time, moderate technological innovation activities are actually beneficial to bank loans. While in the context of the bank-enterprise relationship for a short period of time, the negative effect of technological innovation on SMEs' loans is increasingly obvious. R&D investment plays a more negative role than patent output. Furthermore, the positive effect of the number of authorized patents is stronger than that of R&D investment and applied patents.

The relevant implications can be summarized as follows: First, It's necessary to establish a stable long-term cooperative relationship. SMEs should make full use of social network relationships, establish and develop a sound bank-enterprise cooperation relationship actively on the premise of credibility. Particularly, they should strengthen information exchanges with cooperative banks. Second, it's wise to improve the ability of patent production. SMEs' R&D investment should be targeted so as to avoid the investment with low output efficiency. SMEs can take an active part in enterprise alliances or the industry-university-research alliances, and make the most of the technology spillover effect and collaborative innovation effect of the alliances cooperation, and improve the ability of independent innovation. Third, it's also important to expand diversified financing methods. SMEs should actively seek out venture capital, legal private capital and group loans on the basis of relying on the sources of funds in the endogenous financing and family or friends relation circle.

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