

# Growth Mechanism of Hi-tech Enterprises in Sci-tech Financial Network

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## Abstract

*This paper argues that science and technology financial network is a special system consisting of seven major resources, credit institutions, venture capital investment companies, assessment and guarantee institutions, capital market, governmental administrations, sci-tech parks, and universities and research institutes, these resources around high-tech enterprises the core interactions, formed the unique mechanism: the enterprise financing mechanism, technology innovation mechanism and information transmission mechanism. Reveals the realistic problems, and also proposed an empirical analysis at last.*

**Keywords:** *sci-tech financial network; high-tech enterprise; enterprise growth*

## 1. Introduction

Accompanied by accelerated development of world economy since 1990s, technical innovation has become a main impetus for economic growth. As compared with developed countries, technical innovation capability of China still has a large room for improvement. In 2011, the rate of contribution of sci-tech progress in China to economic growth was lower than that in emerging countries by 20%; whereas average level of sci-tech funds as granted by Chinese government accounted for 0.6% GDP. According to statistics, there are altogether 12, 889 large and medium industrial enterprises engaged in R&D activities nationwide, accounting for only 28.31% of the total; whereas most of small enterprises are in lack of innovation capability. R&D input by enterprises nationwide only accounts for 0.74% of the sales income; whereas that for large and medium enterprises is 0.93%, which is far below the average level of 2.5-4% in developed countries. As definitely stipulated by the State in outline for "Twelfth-Five Year Plan" for national economic and social development, sci-tech progress and innovation serve as an important support for accelerated transformation of economic development mode; according to innovation promoted development strategy as stipulated in the report of 18<sup>th</sup> National Congress of CPC, it is necessary to attach importance to coordinated innovation and construction of enterprise centered technical innovation system featuring in market orientation and combination of enterprises, universities and researches in addition to independent innovation. Therefore, approaches for promotion of integration of science, technology and finance as well as establishment and optimization of sci-tech financial support environment favorable for technical innovation has critical significance to improvement of technical innovation level of medium and small enterprises, promotion of national economic development and construction of an innovation based nation.

In a broad sense, sci-tech finance is the systematic and innovative arrangement for a series financial tool, financial system, financial policy and financial service for promoting sci-tech development, achievement transformation and high-tech industrial development [1]. Science-technology financial practice made its appearance in China in 1980s, which

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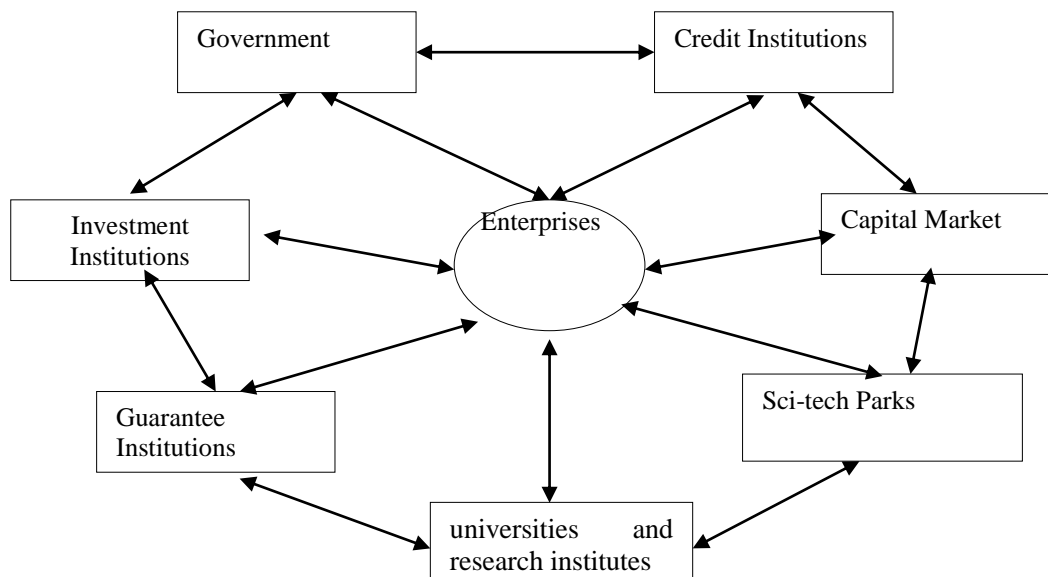
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was represented by grant of initial sci-tech funds; the expression of sci-tech finance was proposed in 1990s. Theoretical study and practice of sci-tech finance are still at the initial stage due to its short history, which require further improvement. As pointed out by Strogatz, network is a thinking mode in most of cases, which is favorable for better comprehension of mutual action between among different subjects or complicated systems [2]. Sci-tech financial network is a new neocategory on the research of sci-tech financial system by social network analysis method, the combination of sci-tech system and financial system, and the complicated system including high-tech enterprises, financial institutions such as bank, intermediary institutions such as assessment and guaranty institutions, capital market, government administration departments and sci-tech parks. Assembly of same subjects shall constitute a sub-system of sci-tech financial system. Meanwhile, all subjects will jointly form an enormous science and technology financial network. Sci-tech financial network is provided with numerous features of network structure; whereas coordination effect is produced between each subsystem through non-linear action to enable the science and technology financial network to form a self organization structure with specific functions. Few researches on relevant technical innovation and financial support in China are associated with sci-tech financial network as embedded by sci-tech oriented enterprises; however, researches on growth of hi-tech enterprises under the sci-tech financial network are in lack of microscopic, dynamic and coupled view points. To solve such problems, it is essential to inquire into the structure of sci-tech financial network and inherent relationship between sci-tech financial network and growth of hi-tech enterprises, and further explore approaches for growth of hi-tech enterprises.

## 2. Structure and Features of Sci-tech Financial Network

### 2.1. Structure of sci-tech Financial Network

There are 8 major nodes in the sci-tech financial network, namely hi-tech enterprises, credit institutions, venture capital investment companies, assessment and guarantee institutions, capital market, governmental administrations, sci-tech parks, and universities and research institutes. Interrelation between each node is as shown in Figure 1.



**Figure 1. The Structure of the Sci-Tech Financial Network**

Among them, hi-tech enterprises are the core subject of sci-tech financial network as

well as a direct behavioral subject of accelerated innovation [3]. Enterprises are in relationship with other nodes in the network. Credit institutions include commercial banks and small-credit companies. Normally, it is applicable to establish sci-tech credit sub-branches in sci-tech parks or sci-tech small-credit companies to support sustainable development of hi-tech enterprises. Governmental departments include central and local governments and their public departments. Governmental department play an inevitable role in accelerating development of sci-tech financial network through improvement of infrastructures and regional sci-tech financial environment, and regulating market and reasonable allocation of resources through stipulation of policies and legal provisions.

## **2.2. Features of sci-tech Financial Network**

(1) Dynamics: Accompanied by growth of enterprises, interrelation between each node in the sci-tech financial network and relevant elements, knowledge and information as contained are witnessing sustainable action and updating; therefore, formation of sci-tech financial network is actually a dynamic process of gradual change and development.

(2) Openness: Interrelation among nodes as contained in the sci-tech network is represented by internal link and external cooperation inside and outside of the network; it is applicable to obtain external complementary resources through increase of nodes inside the network and spread of such elements as network technologies, capitals and labor forces; dynamics of sci-tech financial network is just manifested in this process.

(3) Systematization: Innovation and sustainable development of the network are originated from coordinated action of all subjects in the sci-tech network. Sci-tech innovation will bring benefits to innovators, and convey technologies and knowledge to other subjects via the network through such activities as collective studies; this aims to ensure accumulation of such resources as knowledge in the network, and promote cultivation and development of another innovation achievement.

(4) Decentralization: Decentralization refers to the fact that any node is available for cooperation and communication via the network regardless of its position in the sci-tech financial network; this can minimize loss of resources. Furthermore, all behavioral subjects can make use such decentralized network to minimize market competition and risks to failure in addition to better cooperation and communication.

## **3. Research on Enterprise's Growth Mechanism**

Enterprise's growth mechanism mainly discusses such issues as the enterprise's method of realizing growth, growth motivation, and the way of turning these factors into results. The understanding and research on enterprise's growth mechanism gradually expand with the change of enterprise's growth environmental conditions and the diversification of practical growth activities. The formation of different enterprise's growth mechanisms not only relates with specific era, but also relevant to enterprise's and entrepreneur's strategic intention and preference [3].

### **3.1. Exogenous Growth Mechanism**

The research perspective is based on enterprise's external part. It is a kind of controversial mechanism and method to realize enterprise growth through buying external resources. It generally happens in the enterprise with unbalanced competitiveness. So it belongs to a kind of non-cooperative game. Although this kind of growth method can help enterprise to achieve dramatic expansion, to occupy beneficial market position and to obtain ideal earnings within a short time under proper environment, there are still some defects hard to be eliminated, such as the increase of the costs for production and management, the obtaining of redundant resources to cause burden [4], hard to satisfy enterprise's demands on multiple resources[3], cultural conflict[5], lack of efficiency,

efficacy and flexibility in vertical integration, and failure of reaching expected benefits or effects by many enterprises[6].

### **3.2. Endogenous Growth Mechanism**

The endogenous growth mechanism of resource-based enterprises is proposed by Penrose [7]. He transfers research perspective from external scale economy to enterprise's endogenous growth and he established an analysis frame of "resource – ability – growth". The research perspective of endogenous growth mechanism is based on enterprise's internal part. The research mainly focuses on six components which are closely related with enterprise's growth: including enterprise's capability, arrangement for financing and legal system, industrial evolution, technology and knowledge, information disclosure and capital structure, and uncertainty of environment [8]. This kind of theory advocates that enterprise's growth is completely the result from enterprise's internal resource integration and ability matching. And external environment factor has so little influence to enterprise that can be neglected. This is the growth mechanism generally adopted by most enterprises in "Fordism" production era.

### **3.3. Networked Growth Mechanism**

Michael. Porter (1990) put forward industrial colonization. Wu Aiqi proposed networked growth concept and established the theory framework of "network – network resource - cluster growth" [9]. Chi Renyong analyzed the basic framework of regional innovative network and the linking method of network nodes [10]. And Jia Shenghua researched the influences on the ability of cluster enterprises by global network and local network.

Under complicated cluster environment, the growth of high-tech cluster enterprises is a kind of enterprise growth mode that has interdependent and mutual promotional relation with local network and other organizations. The resource status of local network and that can be obtained from enterprises become the important factor of affecting the growth of cluster enterprises [3].

Existing growth theories mainly analyze enterprise's growth mechanism from single enterprise perspective. However, viewing from social network perspective, the analysis on sci-tech enterprises' growth based on sci-tech financial network lacks of in-depth and systematic research. In particular, it lacks of studies on adaptive cooperation and interactive symbiosis between industrial cluster enterprises and their sci-tech financial network environment to realize networked growth.

## **4. Action Mechanism of Sci-tech Financial Network in Promoting Growth of Hi-Tech Enterprises**

### **4.1. Enterprise Innovation Financing Mechanism**

High-tech enterprise's embeddedness on sci-tech financial social network plays an active role for enterprise to finance with the support of social network. Embeddedness and the relevance with entrepreneurial network will increase entrepreneurial enterprise's integration and deployment of social resources [13]. Provide supports for enterprises at the stage of incubation and enterprising by equity financing, namely venture capital investment. Network belongs to the biggest motivating factor for entrepreneurial financing (MosheShari and MiriLerne, 2006). Financing strategies of venture enterprises are closely associated with its social network and venture development route (JianwenLiao 和 HaroldWelsch, 2003). The success or failure of financing by entrepreneurial enterprise is dependent on the ability and the role undertaken by entrepreneurial enterprise's social network [12], the position and utilization efficiency of

its social network (Timothy Bates, 1997). Sci-tech finance social network can help entrepreneurial enterprise to conquer difficulties, to break the bottleneck and to get rid of constraint. It is applicable to support venture financing of well-established enterprises by means of indirect financing, namely grant of loan. It is also applicable to provide loan as supplemented by equity financing for emerging enterprises.

#### **4.2. Technical Innovation Mechanism**

The core to enterprise's competitive advantage lies in the ability of obtaining, allocating, exchanging and integrating resources, namely, the network [15]. Granovetter divides social network relationship into two categories, namely the strong ties and the weak ties [16]. In sci-tech finance social network, strong ties are good for bringing the knowledge needed by enterprises through exploitive learning. Enterprises can constitute a system beneficial for knowledge exchange and integration by establishing the mechanical network featured in strong ties [17]. The weak ties play the role of "bridge" for enterprises to make explorative learning and to provide knowledge source. As the weak ties are widely distributed, it can get information and resources by spanning over the social boundaries comparing with strong ties [17]. Technical innovation performance has positive promotional effect to the strong ties and the weak ties in enterprise's social capital. And the positive promotional effect on weak ties by innovation performance is higher than that on the strong ties. Information disclosure intensifies the strong ties and weak ties in enterprise's social network. Information disclosure plays an incomplete mediating effect to the influences on enterprise's social capital network relation by technical innovation result [18].

#### **4.3. Information Transfer Mechanism**

Information sharing in the sci-tech financial network has positive effect on financing by enterprises. However, serious information asymmetry is the largest obstacle to financing [20]. The improvement of information management efficiency of enterprise's investors and financing parties has great promotional effect on improving the quality of entrepreneurial financing (Carla Sofia Pereira and António Lucas Soares, 2007). However, every enterprise is under a certain social network node, and has certain information which is not understandable or utilizable by economic entities outside network. For one side, part of the financing information is elusive which cannot be transferred through texts or charts, on the other side, enterprise will intentionally prevent the disclosure of private information which might be attached with great importance to by all financing parties in social network. When carrying out financing activities based on its social network, enterprise is in urgent need to break the "structural hole" to eliminate the information barrier among the cooperative financing parties, and it can play the information hub role of "structural hole" to achieve the information sharing among the social network individuals outside the "structural hole".

### **5. The Empirical Analysis**

#### **5.1. Research Hypothesis**

According to the discussion about various aspects of the theory to the enterprise financing, technology innovation and so on, we put forward two assumptions:

H1: the size of the enterprise financing of high technology has a positive role in promoting the growth of enterprises

H2: Corporate spending on technology innovation can promote the growth of the high-tech enterprises.

## 5.2. The Data Source and Target Selection

Considering the authenticity and desirability of the data, this article selects the data of 20 technology enterprises in the third quarter of 2014, which has been listing in the shenzhen stock exchange growth enterprise market. Using the software Eviews7.0 to do a simple linear regression with the sample data, in order to discuss the two assumptions are put forward above.

Enterprise financing scale is the total funds that the enterprise raises for in a certain period. In the process of production and operation the lack of funding, enterprise has to seek to financial support from the enterprise external. Due to financing from the external needs to pay a certain price, so enterprises must to determine their own financing scale first before the financial plan. If it is too large of the financing scale, there would cause idle funds or the waste of resources, and increase the cost of financing; or lead to much debt to enterprises. Therefore, they would be unable to withstand it, it is difficulty to repay the debt, and raising business risk ,too. But if financing scale is too small, it will affect follow-up management and normal development of the enterprises. Therefore, it is a necessary condition to have a reasonable financing scale for the healthy development of the enterprise. Because of paper selected the relevant data of different enterprises to compare, so we selected the total amount of financing to be the measure of financing scale:  $X_1$ =the total amount of financing.

Technology innovation, many scholars have researched the enterprise technology innovation from different angles, it refers to the enterprises' innovation on production technology, including new technology developed by themselves, and the application innovation of the existing technology. Intangible assets are owned or controlled by enterprises, which without physical form and identifiable non-monetary assets. It includes The patent rights, non-patented technology, trademark, copyright, land use rights, franchise *etc.* So in enterprises with high and new technology, we consider that the intangible assets can be used as quantity index of the enterprises' technology innovation. We selects the intangible assets of enterprise financial statements to measure the technology innovation:  $X_2$ = The total amount of intangible assets.

The business enterprise growth, Penrose (Penrose, 1959) put forward the enterprise's internal growth theory, he take the single enterprise as the research object, analyzes the process of the growth of the enterprise. Domestic scholars divide the growth process of enterprises in different ways. Generally, according to the change of the enterprise's sale, the enterprise growth process can be divided into four phases: early stage, growth stage, mature stage, the recession. While the relevant indicators of business growth is the growth rate of total assets, The growth rate of main business income, increasing rate of fixed assets *etc.* As this study is to analyze the data of different enterprises, unable to use the growth rate of these indicator, so we selected the absolute number to the empirical research. In this paper, we selected two indicators: the operating income and total assets of the enterprise:  $Y_1$ = operating income,  $Y_2$ =total assets.

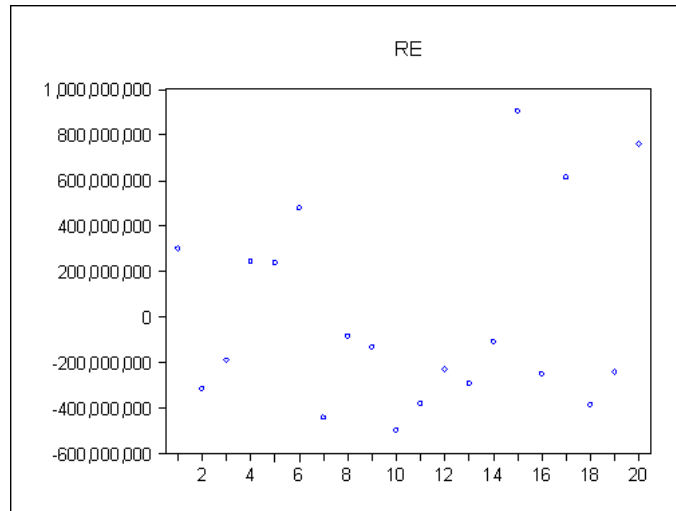
## 5.3. The Variables Descriptive Statistics and Correlation Coefficient Test

**Table 1. Descriptive Statistics**

	business income $Y_1$	total assets $Y_2$	financing scale $X_1$	intangible assets $X_2$
Mean	900952834. 38	1991477969. 76	392227736. 70	59903827. 01
Median	848493452. 48	1764913933. 76	302283528. 00	51713170. 25
Maximum	1838352650. 45	5104452348. 12	1323537143. 00	150328424. 71
Minimum	141560448. 95	512171872. 90	118000000. 00	4636194. 90
Std. Dev.	554641735. 59	1255134421. 09	278813830. 07	39409858. 37
Skewness	0. 19	0. 90	2. 08	0. 72



C	1.96E+08	2.27E+08	0.862956	0.4002
X <sub>1</sub>	1.020570	0.367610	2.776230	0.0129
X <sub>2</sub>	5.089615	2.600739	2.156988	0.0670
R-squared	0.423021	Mean dependent var	9.01E+08	
Adjusted R-squared	0.355141	S.D. dependent var	5.55E+08	
S.E. of regression	4.45E+08	Akaike info criterion	42.80430	
Sum squared resid	3.37E+18	Schwarz criterion	42.95366	
Log likelihood	-425.0430	Hannan-Quinn criter.	42.83346	
F-statistic	6.231906	Durbin-Watson stat	2.059945	
Prob(F-statistic)	0.009330			



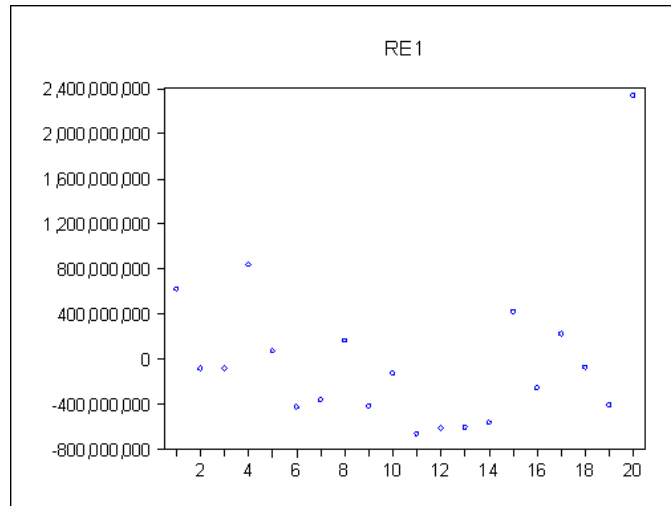
**Figure 1. The Regression Results 1 Standardized Residuals Chart**

**Table 4. Regression Results 2**

Dependent Variable: Y<sub>2</sub>  
 Method: Least Squares  
 Date: 03/09/15 Time: 19:49  
 Sample: 1 20  
 Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-57664891	3.72E+08	-0.154956	0.8787
X <sub>1</sub>	2.958502	0.603023	4.906120	0.0001
X <sub>2</sub>	14.83605	4.266219	3.477564	0.0029
R-squared	0.696822	Mean dependent var	1.99E+09	
Adjusted R-squared	0.661154	S.D. dependent var	1.26E+09	
S.E. of regression	7.31E+08	Akaike info criterion	43.79416	
Sum squared resid	9.07E+18	Schwarz criterion	43.94352	
Log likelihood	-434.9416	Hannan-Quinn criter.	43.82332	
F-statistic	19.53636	Durbin-Watson stat	1.487391	
Prob(F-statistic)	0.000039			





**Figure 2. The Standard Error Diagram of Regression Results 2**

In Table 4, The F value of model 2 is 19.53636, the corresponding P value close to 0, so the model is significant at the significance of 1% level. The adjusted  $R^2$  of model 2 is 0.661154, better fitting. The value of D.W is 1.487391, through checking the table we know that  $Du=1.41$ (when  $n=20$ ,  $k=2$ ). The value of D.W is between Du and  $4-Du$ , so the model 2 does not exist correlation. Figure 2 shows that the distribution of each point is random in the standardized residuals, does not present a certain trend, which illustrate that model 2 does not exist heteroscedasticity. According to the result of regression results 2 we wrote out the equation of model 2:

$$Y_2 = -57664891.4057 + 2.1569880247428 * X_1 + 14.8360493139 * X_2$$

(4.906120)
(3.477564)

Under the significance level of 5%, when the degrees of freedom is 17, the T statistic's critical value is  $t_{0.025}(17) = 2.11$ , so the parameters of  $X_1$ ,  $X_2$  are significantly different from zero. Model 2 shows that when the financing scale ( $X_1$ ) changes 1 unit, business income will change 2.1570 units; When the total amount of intangible assets ( $X_2$ ) moves 1 unit, business income will change 14.8360 units. According to the regression results of sample data, we validate hypothesis 2: The investment of enterprises in technological innovation will promote the growth of high-tech enterprises.

## 6. Conclusion

Sci-tech financial network is formed by sci-tech system and financial system, which is provided with numerous features of complicated enormous systems and networks; it features in numerous elements, complicated mutual relationship and adherence to mechanism for growth of hi-tech enterprises in the sci-tech financial network, which is closely associated with structure of sci-tech financial network, information transfer mechanism in the network and mechanism for coordinated innovation of network nodes.

(1) Factors influencing the structure of sci-tech financial network include financial demands for innovation of enterprises, risk intensity, expected investment return and credibility of enterprises; identification of critical factors influencing the structure of sci-tech financial network, analysis of causal relationship between the growth of hi-tech enterprises and influencing factors in the process of development and evolution of sci-tech financial network and establishment of systematic dynamic model for sci-tech financial and social network constitute a topic for further study.

(2) Sci-tech financial network are linked with different subjects in the sci-tech network by taking innovative financing as its linking mechanism. Among them, hi-tech enterprises

constitute the subject for sci-tech innovation; government, bank, investment institution and capital market constitute the subject for innovative financing; whereas guarantee companies serve as the subject of financial services. Such subjects are provided with discretion in selection of respective links; whereas formation of sci-tech financial network relies on strategic decisions of numerous subjects. Then, what are approaches for impact of strategic behavior of aforesaid subjects on the formation and evolution of sci-tech financing network and control of strategic behavior of such subjects on the micro level by the structure of sci-tech financing network on the macro level? Further study is expected to solve problems with quantitative description of strategic behavior of aforesaid subjects, and realize integration of such strategic behavior and mutual influence between it and network structure.

(3) The researches on enterprise financing in sci-tech financial network mainly focus on enterprise's entrepreneurial stage, namely the enterprises in founding period and the early growth period. However, the researches on the growth support and financing of enterprises in full life cycle period are rather few. In terms of enterprise's technical innovation, the researches about the issues of enterprise's technical innovation and social capital, especially financial support are very little. And the past researches did not segment enterprise's development periods. The different stage of enterprise's growth will inevitably cause the differences in enterprise's technical innovation activities and enterprise's social capital. Choosing sci-tech enterprises as a sample to make the research is mainly because of that this type of enterprise's survival and development takes innovation activity as the basis and motivation. And as this type of enterprise has weak capital accumulation, so the financial support has an important supporting effect for carrying out technical innovation activities.

(4) Technical innovation serves as the basis and impetus for the growth of hi-tech enterprises; whereas financial support serves as an important support for technical innovation of enterprises; however, few researches are related to interrelation between technical innovation of enterprises and social capitals, especially financing support; furthermore, previous researches have failed to give a detailed division of development stages of enterprises. As different development stages of enterprises may result in discrepancy to technical innovation and social capitals of enterprises, it is essential to inquire into growth mechanism of hi-tech enterprise in its whole life cycle under the support of sci-tech financial network. It is applicable select three typical stages for the development enterprises based on their life cycle: Take venture, growth and mature stages as subjects for study to analyze potential structure of sci-tech financial network at different development stages of hi-tech enterprises (network scale, social network density, network discrepancy, relation embeddedness and reliance on strong and weak relationship) for modeling of sci-tech financial network and quantitative description of rules for evolution of sci-tech financial network and its influence on the growth of enterprises during sustainable development of enterprises.

(5) Generally speaking, researches on information sharing in sci-tech financial network mainly focus on the elusiveness of enterprise's node information on network. There are only a few researches about the information sharing and information flow of all aspects of nodes for providing financial support and financing. As "sci-tech finance" can be explained as a kind of linking mechanism for finance to promote sci-tech innovative network, the government embeds financial trading structure through financial funds. Therefore, the revelation of the linking relation and information flow mechanism of financing enterprises and technical innovative enterprises on sci-tech financial network has important significance on increasing sci-tech enterprises' credit and reducing financial institutions' Risk and trading costs. And it is an issue need to be further studied.

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