The Relationship Between CTO External Social Capital, CTO Technology Strategy Participation and Technological Innovation Performance

TANG Zhen¹, ZHANG Jing², ZOU Jun³
Business School of Hohai University, Nanjing, China, 210098
tzzsterry@163.com

Abstract: The paper absorbed research results on social capital, technological innovation performance from domestic and foreigner. On the basis, this paper from the individual level perspective of a CTO and in charge of the CTO who is the head of technology management in an enterprise, on the relationship of the external social capital they owned with technological innovation performance. At the same time, the paper from the perspective of technology strategy, explored the intermediary role of CTO technology strategy participation in the following relationship, the related conceptual model was also proposed, as a start-ups exploration in this field, hoping to enrich the community Capital Research’s content, and to expand the corresponding knowledge. Also, this study surveyed high-tech enterprises in China, in order to test the above conceptual model, the following are conclusions: the structure dimension, the relationship dimension, the cognitive dimension of CTO external social capital are related to CTO Technology Strategy Participation and Technological Innovation Performance; CTO Technology Strategy Participation is play an intermediary role in the relationship of CTO External Social Capital structure dimension, relationship dimension and Technological Innovation Performance.

Keywords: CTO, External Social Capital, Technological Innovation Performance, Technology Strategy Participation, Chinese high-tech enterprises

1 Introduction

With the global economic integration and international competition becomes more complex, the market demand become rapidly changed and difficult predicted, companies can’t just rely on the possession of scarce resources, they must gain competitive advantage by continuous learning, knowledge creation and improve the technical innovation. Among them, the competitive advantage of the resource base also depends not only on internal self-owned, also depends on a variety of resources and capabilities in a variety of social relations embedded in the network which is difficult to imitate by competitors. Then, many companies turned to outside sources strategy for technology innovation. Domestic and foreign companies have begun full focus on cooperation and communication with suppliers, customers, universities and research institutions and other external resource entities, As Allen said, the best way for transfer technology information is mobilize the people who own information. As the top management of enterprise, CTO and external resources’ interaction have a constructive activity to the technological innovation. In conclusion, CTO External Social Capital should become an important research topic of technological innovation.

CTO position originated from some of the research and development laboratories with large companies such as GE, AT & T and ALCOA in the 1980s. For now, CTO position is relatively new, but in many different types of enterprises, which are widely used. There exist significant differences in understanding the role of CTO, also there are major differences between companies, which is one of the large dispute in the industry since the CTO name inspected. This is mainly due to the different types and different development stages of enterprises, and also the content of CTO is different, but on the whole,
CTO with some of the occupation in common made them accumulate a certain degree of social capital, mainly include the followings: ① CTO is a technology leader. ② CTO is a co-coordinator of the enterprise. ③ CTO is a driver of innovation. The following duties and contents make CTO can better contact to the technical innovation of the source of technological innovation, and has a certain technology-related social capital. Meanwhile, CTO also serves as an important bridging role between the organization-organization relationships, which also makes him have social capital in technology. In addition, Leonard-Barton, Vonhipple and other scholars believe that the ways for many enterprises to increase the stock of knowledge are as follows: In-house R&D institutions; suppliers; customers; competitors; public sector. Meanwhile, they further point out that most companies need external knowledge sources for innovation. Therefore, for an enterprise, how to effectively absorb external knowledge is very important to its success. In the past development process, companies often focus on the effectiveness of the internal R&D which were played by the top management of enterprise’s internal technical aspects, and paid little attention to the external sources of technology innovation, with the technology played a more and more important effectiveness in the enterprise, how to better use the enterprise’s top management CTO’s external social capital, and make it effectively play its role, all of these issues need to be studied.

In addition, Smaltz and other people have pointed out that a CTO despite its own technology and experience, but his contribution is not likely to impact on the business performance, to focus this problem, the upper echelons theory from human capital has made some explanation. But with the gradual deepening of the study, more and more evidence that the need to strengthen the role of managers’ role in strategic decision-making. John W. Medcof also pointed out that the company’s CTO should have a high degree influence on the corporate strategy, and made the technical factors strongly influence strategy. Only when the CTO has influence in strategic decision-making, and developed powerful embedded relationship at the same time, they can help CTO to carry out its functions, and make their social capital in playing effectively influence to the firm performance. In this process, CTO technology participation is an important performance for technology strategic decision-making, so the level of CTO technology strategy participation may lead to the relationship of CTO external social capital and technological innovation performance have a certain difference. Consider the above; this paper explored the relationship between CTO External Social Capital, CTO Technology Strategy Participation and Technological Innovation Performance.

2 Literature Review

2.1 Social capital
Nowadays, the research on social capital is in the development stage. There are many research findings, most of which see social capital as a productive resource that promotes the cooperation between actors, or as a capability that promotes the actors to obtaining benefits through social network links. Specifically, Loury considers the social capital as the natural form of social relations which promotes or contributes to obtain the valuable skills and characteristics. Nahapiet et al regards the social capital as the sum of actual and potential resources. It embeds in, stems from or through the relation network that the individual or social unit possesses to use these resources. Therefore, the social capital consists of networks and the assets flowing in the networks. Kurt Annen thinks that in the social networks, based on the reputation of the co-participants (individual or organization such as families, enterprises, countries etc.), the higher reputation the co-participants perform, the more social capital they have. Although there are some differences in the definitions of social capital the scholars given above, according to these definitions, this paper sums up the characteristics of social capital as the followings: capital, producibility and sociability, which means the social capital needs to cost some time and efforts to build, can bring profits to the actors and occurs between the groups.

Research on social capital, according to the different of the study object, can divide into three levels: macro-, micro- and meso-. At the micro level of social capital research, the research on the social capital
of entrepreneurs who act as an important force connecting the internal and external subject is outstanding. Westlund believes that there is a link among the social capital of entrepreneurs, opening the way, innovating the enterprises and settling the social problems. Ossic Jones and Kevin Boles considers the social capital of entrepreneurs as the product of cooperation among various business partners, networks and institutions embeds in the local culture and customs, as well as the supported networks of entrepreneurs fundamentally focuses on the resource and profits. Lulu Li defines the social capital of entrepreneurs from the micro level as social relations the entrepreneurs possess. It contains two indexes: a relationship person which the entrepreneurs choose and is mostly close with them; the occupational status and job status of this relationship person indicates the differences in social capital. Moreover, Xiuying Shi thinks that as the crucial connection point of enterprises and social environment, the entrepreneurs must have the ability to obtain the necessary resources including four critical resource, administrative and legal resources, management and operational resources, productive and operational resources, spiritual and cultural resources.

Furthermore, in the measurement of social capital, there are two universal modes: one is dividing the social capital into external and internal social capital; the other is dividing it in multiple-dimensions. The typical research on this area is the dimension model of social capital Nahapiet and Ghoshal raised. Integrated the existing literature involving the structures, contacts, trust and cognitive perspectives etc, they divided the social capital into structural dimension, relational dimension and cognitive dimension. The other scholars also consider fusing these two methods to better measure the social capital. Then, based on these, most research made a set of adjustments and modifications.

In sum, today research on social capital in micro level, especially in social capital of entrepreneurs is in development stage. There are many research findings. Most research has discussed the concepts and measurement methods, and provides the theoretical foundation for the research in micro level.

2.2 Technology strategy

Corporate technology strategy, at fist is the R&D activity of technology management of large enterprise, then, is used to express the technology dimension of enterprise strategy. Until the late 20th century, as the technology development strategy gradually went deeper into the enterprise level, the concept of enterprise technology strategy has been formally established, and gradually developed. But until now, there isn’t a universally accepted conception of it. Most scholars have defined the meaning of the enterprise technology strategy from their own perspectives. In the early studies, Burgelman and Rosenbloom think the enterprise technology strategy expresses the function of the quantities and qualities of the relative technology capabilities which are supportive. This technology strategy is enterprise R&D strategy. Rieck and Dickson consider the technology strategy as the way how to deploy, allocate and integrate the company’s technology resources to achieve its competitive goals. Technology strategy management involves technology positioning, competitor analysis and R&D strategic direction etc. Then, as the technology inside and outside level of the enterprise is gradual important, the importance of technology strategy is also increasingly being recognized, not just the same as R&D strategy. From the perspective of competitive advantages, Poter puts the technology strategy into the integrated value chain of enterprise, surpass the traditional R&D, thinks it can play a role in supporting various basic strategy. Narayanan considers the technology strategy as the form of technology choice of enterprise, emphasizes it not only need the enterprise to plan, but also need to implement, and points out that technology strategy is the notion emphasizes the implementation processes. In the technology strategy studies, there is another hot spot issue, the composition of technology strategy. As can be seen from above, there is no uniform definition of the technology strategy, which leads a big difference of the content of technology strategy.

Maidique and Patch regard the technology strategy is consist of five dimensions, type of technology, internal and external sources of technology, R&D investment level, timing of technology introduction and R&D organization. Zahra’s opinion about composition of technology strategy includes five aspects: form of advanced technology, product technology portfolio, technical skill portfolio, internal R&D
investment, external technology sources, technology forecast. Hampson defines the content of the technology strategy from five perspectives, competitive positioning, technology sources, depth of technology strategy, width of technology strategy and adaptability of organization. The different perspective of classification made different research findings of classification of technology strategy of enterprise. But in general, there are some common ground among different definitions. As Narayanan pointed, there were two important dimensions, range of options and leader statues, which must have to concern during the process of classification. In a word, as the increasing competition and rapid changes of technology, there is a need to expand the range of enterprise strategy, not just focus on the internal enterprise how to adapt to external changes timely and make relative modification, but become a problem necessary to consider during the process of corporate strategy formulation. Moreover, technology is up to the enterprise strategy level. The integration of the technology and the enterprise strategy become the new trends of strategic management. Therefore, from the perspective of the leadership, technology strategy should have to become the important aspect of senior executives developing strategies and making decisions. Whereas the studies about these are still lacking, research on the comprehensive consideration of these two factors is the blank space.

In sum, scholars’ studies on enterprise technology strategy is plenty, obtaining a great many research findings, and make the theoretical foundation for this paper. But there is still inadequate of research of sub-division direction. Through the review above, this study suggests that it needs to be further explored in the composition of enterprise technology strategy.

2.3 Technological innovation performance

Theoretical point of view of technology innovation was pointed firstly by J. A. Schumpeter in his monograph “Theory of Economic development”, “innovation is the process of establishing a new production function, such technology innovation applies to the economic activities that leads to reset the production factors and production conditions, to obtain the potential profits”. Schumpeter’s innovation theory is the major breakthrough of the world history of economic thought. As the increasing importance of scientific and technological progress in economic development and the gradually deeper research, research on technology innovation theory is from Schumpeter’s economic perspectives to management perspective, then evaluating to the sociological perspective. According to this, domestic and foreign scholars, such as Freeman, Mole etc, made a lot of research. Scholars studied the technology innovation activities from different perspectives, which can be summarized as four notions: 1. product view; 2. process view; 3. product and process view; 4. multiple views. Specifically, there is no uniform conception of the technology innovation performance. The main opinion of the meaning of the technology innovation performance focuses on the impact of the input-output efficiency of technology innovation and output of innovation activities on enterprises. Hagedoorn and Cloodt consider innovation performance narrowly as the results measuring by the degree of the enterprise introducing the innovation to market, consider it broadly as the performance, including invention, technology and innovation, obtaining during the entire process from concept generating to introducing the innovation to market. China scholar Jian Gao believe the technology innovation performance is the efficiency of process of technology innovation, output results and contribution to business success, including technology innovation output performance and technology innovation process performance.

On the measurement of technology innovation performance, scholars usually select indicators to measure the innovation performance according to the factors such as the sample characteristics, which industry is the enterprise’s main business, which country the enterprise is in, database etc. Many studies use single indicators, mainly including R&D input, number of patents, number of patents cites or number of new products, while the other research use two or more indicators to constitute measurement system. Hagedoorn and Cloodt use indicators, R&D input, number of patents, number of patents cites or number of new production, in the research of the technology innovation performance of high-technology industry. Fanghua Zhang use five indicators from both innovation efficiency and innovation benefits sides to measure the technology innovation performance. In the study, some scholars select the number
of new product to measure innovation performance. But Devinney through the study found that the variance which the number of patents can explain the number of new product is less than 3%. The positive correlation between the number of patents and new products is able to confirm in industrial level not in enterprise level. Furthermore, the correlation between them is weak. Although as the indicator to measure innovation performance, the number of patents has its drawbacks, it is still the fittest indicator selected by many relative literature to measure innovation performance.

For a long time, in management and economics fields, most research on the measurement of innovation performance is from innovation benefits or innovation efficiency, single perspective. It has flaws that can't measure the performance comprehensively and reasonably. Hagedoorn and Cloodt through the study show that there are statistically overlapping between these indicators, so they suggest only using one of these indicators can measure the enterprise technology innovation performance better. Furthermore, this study considers that the core of technology innovation is product innovation; the output of technical skills also needs product to reflect, therefore, the performance of technology innovation which the product innovation as the main part can be reflected through the empirical investigation of product innovation. In view of thinking, this study is still using the multi-item measurement system to measure technology innovation performance, but the main consideration is the product innovation.

External social capital breaks up the lacking of using the resources of enterprise itself, promotes its technology activities. Maskell point out that the social capital of enterprise promote the technology innovation performance through cutting the deal cost of enterprise and between enterprise and external organization. Yli-Renko and Autio indicate that, in “new economy”, innovation is realized more by a dynamic production relation or network of co-creating value, and the social capital has become the key factor of technology innovation. In the empirical analysis, through the research on the mobility of the scientists participate in R&D in fortune 500 enterprises, Gabbay and Zuckerman found that the impact of the social capital on the R&D shows significant difference upon the characteristics of R&D. All these show the social capital and technology innovation performance has some correlation. Specific to the subject of this study—CTO, their social capital whether has correlation with the technology innovation performance. Present study for this problem is still a blank space, so this paper will discuss this problem. Through the reading and sorting of the existing literature, the study finds the internal social capital has some impact on the relation between external social capital and technology innovation performance, so it is necessary to consider to bring this factor into research and further investigates the mechanism how the external social capital is effective on technology innovation performance. Moreover, it also can be summed up from the literature review that a more important part in this process is the impact of the external social capital on technology strategy. Only the effective formulation and implement of technology strategy can affect the performance of technology innovation. According to this tread, the effect of CTO’s external social capital on the performance can be achieved through the impact on the decision-making of technology strategy. Then from the view of technology strategy, in the organized framework following the existing norms, values, customs and traditions, CTO is only the participator in the process of technology strategy. The difference of the efficiency of technology strategy between organizations do not depend on whether the CTO possess the decision-making initiative, but depend on the degree CTO participate in the decision-making from various aspects. Therefore, the degree of CTO making decision of technology strategy, the internal social capital of CTO possess, maybe play a intermediation role in the relationship mentioned above. Based on the theories and research assume above, this study proposed the theoretical model as follows:
3 Research Hypothesis

3.1 The relationship between CTO external social capital and technological innovation performance

On the part of outside social capita, Powell and others through the study found that innovation and strong industry generally have the following characteristics, those are closely inter-organizational networks, partnerships generally, a strong sense of information transfer and access to other features. Hippel also pointed out that with customers, suppliers, competitors and other non-market networks and alliances formed by the main technical innovation is the key element of the source. Gulati reckons that the network allows businesses to get more from the external environment, access to information, capital, services and other key resources, and to maintain these critical resources have the potential to enhance competitive advantage. Lawson and Samson think that social capital is the cost, risk, and achieving economies of scale, reduce new product development time effective way. Hagedoorn and Duysters in research external source of innovation capacity pointed out that as a complementary external innovation networking is endogenous in terms of capacity as a supplement to help businesses by sharing resources to master the complex technologies to enhance learning and innovation. Luo Ronggui and Li Wenjun in the study also pointed out that in addition to technological innovation within the enterprise can be accumulated, but also through the technical cooperation between enterprises is improved for high-tech industry, business and technical cooperation between the two sides for cooperation technological innovation play a positive role in strengthening. In addition, Wu Zhiwei also pointed out that the establishment of trust based on the enterprise with suppliers and other partners, a good positive relationship is an important driving force to promote technological innovation. Further, some scholars based on the enterprise and the link between various external entities are directly or indirectly confirmed these contacts for business performance with a role in promoting technological innovation, in this research, the foreign scholars are Cooke and Clifton, Tsai and Ghoshal, and others, domestic scholars have Zhangfang Hua, Chen Jin, etc.

In traditional social capital research, more is to be divided into structural dimension, relationship dimension and cognitive dimension, because of the way in the field of management in social capital research provides a clear analysis framework. There are many researchs on the relationship between CTO external social capital and technological innovation performance, the analytical framework has been applied in empirical studies on external social capital (eg Adler and Kwon). In the structure dimensions of social capital, Burt thinks that the company may obtain the information they need from external suppliers, alliance partners, competitors, trade associations, etc, other things being equal, companies and their ability to access information proportional to the number of links with. In the relationship dimension of social capital, Scott thinks that from outside the enterprise point of view, cooperation between the two sides established a trust relationship can improve the absorptive capacity of enterprises to make all parties more willing to share contacts and exchange information to promote technological innovation. In the cognitive dimension of social capital, Nahapiet and Ghoshal pointed out that establish shared with outside the same language, when it reaches a certain level, can facilitate access to enterprise information. The sharing of information between enterprises for technological innovation capacity-building and technological innovation to improve performance have a certain effect.
As CTO, Smith lists the major duties of a CTO's list, including: monitoring and evaluation the potential of new technologies for new products or services, supervision of research projects selected, ensure that they have the potential and value for the company (strategic innovation), provide reliable technical assessments for potential acquisitions, explain to commercial media of the company's products and future plans (marketing and media relations), Participation in government, academia, and industry group's activities to improve the company's reputation and to capture valuable data. Lorenzen, Tietze, etc. find relevant qualifications of CTO in the following: Long-term business of professional experience; experience as a CTO or senior project manager; long experience in team management; experience with suppliers and third party negotiation; CTO must have a track record of achievement; international experience. Thus, CTO of the responsibilities has some changes, which need to tap its external social capital may play a role.

In summary, the external social capital break up the original simply using their own resources lacking, have a certain role in promoting technology innovation activities. Further, the external dimensions of social capital for all the impact of technological innovation performance has also been more theoretical and empirical confirmation. The best way to transmit information is to mobilize people with information, as the technology of top management within the enterprise, CTO's external social capital may play the role of technological innovation performance of enterprises will have a positive role in promoting. Thus, we propose the following hypothesis:

H1a: CTO’s structure dimension level of the external social capital is related to technological innovation performance;

H1b: CTO’s relationship dimension level of the external social capital is related to technological innovation performance;

H1c: CTO’s cognitive dimension level of the external social capital is related to technological innovation performance.

3.2 The relationship between CTO technology strategy participation and technological innovation performance

In the traditional strategic decision-making, whether it is top-down or bottom-up, CEO is always the central figure of strategic decision making, CTO and other executives often play the role of smart match, but CTO participate in decision-making Committee because of its important role in strategic decision-making. By virtue of its technical advantages, CTO can provide technical advice to senior managers to help the development of effective technology strategies. In late 1980s, Adler and Ferdows conduct a questionnaire survey on CTO of the top of the U.S. Fortune 100 companies, they found that all of the CTO that they are "responsible for the company's highest technical issues, executive vice president." In addition, they also need to take assessment of the technical aspects of the strategic initiatives of the biggest responsibilities. In addition, Roberts is responsible by the Massachusetts Institute of Technology, a research and development on 209 multinational management of large-scale survey also showed, CTO in the development of technology strategy with a high degree of participation. Smith listed a list of CTO duties, in which the important role of CTO for technology strategy, especially innovation and technology strategy has gained further emphasized. John W. Medcof propose when studying the organization influence of CTO that all the company's CTO should be on the company's strategy is highly influential, so that technical factors have a strong impact on strategic. Thus, as Uttal says, CTO may take an increasingly important strategic role: functional, strategic, and the ultra-functional. One function of leadership is the exercise of the right technology, and strategic leadership emphasizes the development of strategy and corporate strategy to maintain the importance of heterogeneity. In addition, ultra-functional leadership for the entire organization is doing the right thing, and doing things right. As can be seen from the above literature, CTO's role is gradually shifted from technical personnel to strategic decision makers, especially in the technical aspects of strategy-makers, thus, its technology strategy will also have a certain degree of participation.

With the technical factors to the strategic level, the height of technology integration and corporate
strategy, has become a new trend of strategic management. Zahra and Covin take a U.S. research on 368 companies indicating that enterprises in the development of technical competence need to focus on the development direction of technology and the company's main production, value-added approach to a high degree of matching, it can promote the capacity and resources to successfully serve the company's corporate strategy, in order to establish long-term competitive advantage. In addition, research shows that senior management is to determine the overall technology strategy and business strategy to effectively integrate the important factors. Burgelman, also pointed out that technology and innovation-related issues and problems are all part of the work of general manager, general manager of an important task is to obtain, shape and configuration technology and innovation resources. As a result, technology executives is becoming an important part of the develop strategy, while the CTO is responsible technology course participant for technology strategy development, and the CEO, CFO, CIO and other people involved in corporate technology strategy development and selection. Specifically, Rieck and Dickson think that technology strategy is to achieve its corporate objectives and how to deploy commercial competition, distribution and integration of its technical resources, strategic management of technology companies includes technology positioning, competitor analysis, as well as R & D strategic direction and so on. With the gradual increase of the importance of technology, technology strategy is also gradually being high-tech companies rely on. Further, Porter also pointed out that the strategic choice to match with the company's technology strategy is an important condition for enterprise high performance in the fierce competition and volatile market environment, because the technology strategy of matching corporate strategy to ensure the company's technical capabilities and technology resources in achieving the company's strategy to develop long-term goal to maximize the effectiveness of the process, allowing companies to build sustainable competitive advantage. The company was originally established CTO for the purpose of this position being used to ensure that senior management can reasonably concern about the business of technology performance. In addition, CTO is enterprise technology spokesperson, who focuses on the business and development, being more familiar with technology for enterprise and industry technology trends. CTO is also the head of corporate technology strategy, he can be their own financing for technical advice into the enterprise technology at the strategic level. On the other hand, CTO of a full member of the executive team participation may be another mechanism. CTO affects other executives, and the executives have the right to decide the company's overall strategy and implementation of competition policy to play the role of coordinator between strategy and corporate strategy, promoting technological innovation performance. Further, the Turkish scholar D. Cetindamar and O. Pala proposed in the study of the relationship between the CTO and performance that the executive team member relations and the relationship between the CTO role and performance are related, and studies have confirmed this hypothesis. Thus, we propose the following hypothesis:

H2: CTO technology strategy participation is related to technological innovation performance

3.3 The intermediary role of CTO technology strategy participation to external social capital and technological innovation performance

CTO is a relatively new position. In China, many high-tech enterprises have set up this position, and as a top technology company spokesman, CTO has been recognized by many companies. In addition, through the existing literature on foreign sort, CTO is generally defined as the strategies and techniques, who is a bridge connecting technology and strategy.

The CTO of Symantec thinks that the main roles of CTO is to provide technical visions to complement the original business, and set the tone and direction for the company's technology, whose basis requires its current products and knowledge for where the external related fields of innovation and change to a more detailed understanding. But in the long-term study, the analysis of CTO role and performance have always existed problem, which is: what factors influence the role of CTO's contribution? Address the problem, the upper echelon theory proposed a useful starting point that the senior management structure of the population is highly likely under conditions of uncertainty. This indicates that executives unique
knowledge, skills, abilities, perspectives and experiences can be important organizational resources. However, with further expansion of the study, we can find that: although a CTO's major personal characteristics they possess represents the unique human capital, they are not sufficient alone to explain the contribution of CTO on all aspects of business performance. In fact, growing evidence also shows that the effect of entrepreneurs and CEO's contribution to organizational performance should be measured through the CEO maintaining the relationship between inside and outside, in particular its role in strategic decision-making. Smaltz, who also pointed out that despite its own technology and experience, CTO's contribution is not likely to impact business performance, unless the CTO has the influence of the executive team, and develop powerful embedded relationship, to help its implementation CTO functions and effectively impact their business performance. It has some reference to the study of CTO. Evaluating CTO external social capital can improve our understanding of CTO affect performance, but the process also need to consider CTO technology's role during the strategic decision-making process and its level of involvement impact.

In empirical research, Thurlings and others interviewed 25 CTOs and 22 scholars by semi-structured interviews and a repeat survey methodology, in which they found much CTOs recognized the strategic management of innovation activity would gradually focus on the value chain, which the company innovative strategies to integrate competitors and other key stakeholders such as customers or suppliers, in addition they also further highlighted the technology's role in corporate strategy. When studying CTO organization impact, Medcof also pointed out the influence of technology on business more important, CTO of the organization the greater the impact of the strategy, CTO is also easier to get through the influence of technical expertise, further, all the company's CTO should have a high degree of influence on the company's strategy, so that technical factors strongly influence strategy. CTO’s external technology sources of social capital is an important way to obtain, and these resources are very important for business success, many scholars have pointed out that the company's development and implementation of these techniques may achieve superior performance.

Further, Michael has pointed out that resources and investment which gained in innovation and technology must have a direct link with corporate strategy, in fact, there won't be a successful enterprise which only take a single technology strategy. Only integrate technology strategy and the business strategy together can bring the beneficial performance for enterprise. On the one hand, the enterprise decided the resources of technology strategy and technology strategy of execution. The enterprise must invest their resources to carry out a series of technical options, and these decide the scope of technology strategy and the leading level of choice in enterprise. That makes the enterprise performance in different ways. The source of technology is the basic condition of the strategic decision technology, and is a support for comprehensive competition strategy and form. The external social capitals of CTO grasp certain technical source for enterprise, and provide the safeguard for the technical strategy planning. But in the enterprise, Nan Weiner think the enterprise management layer affect the performance. But the size of the effect is mainly dependent on who play the leading role. And the degree of CTO technology strategy participation is an important symbol in its role of the management and is an important way to master the enterprise strategy. This would make CTO give coordinated function in these two links, and matched the external social capital with the enterprise strategy. Not only use technology to cater to the enterprise profit independently can ensure the match of enterprise technology strategy and business strategy, thereby, bring the positive performance output for the enterprise. Therefore, the differences in CTO technology strategy participation are likely to make an effect between the relationship of external social capital and technology innovation performance. Thus, the paper concluded the assumptions as follow:

H3a: CTO technology strategy participation has mediating effect between CTO external social capital structure dimension and technology innovation performance
H3b: CTO technology strategy participation has mediating effect between CTO external social capital relationship dimension and technology innovation performance
H3c: CTO technology strategy participation has mediating effect between CTO external social capital
cognitive dimension and technology innovation performance

![Figure 2 The conceptual model in this study](image)

4 Sample and Variable Measurement

4.1 Sample and Data
The research object of this article is CTO in China's high-tech enterprise, including the highest technical director of the IT industry, communications industry and other high-tech enterprises. The reason why select high-tech enterprises is mainly because of for these companies, the technological innovation for the development of enterprises has a very important role. In the high-tech enterprises, due to the importance of technology, making the CTO could take a leading role, and thus research the relationship between CTO external social capital and innovation performances are more likely to have a certain practical significance. Further, in this research, in order to ensure adequate sample size, the survey focused on areas which have more high-tech enterprises in China, such as Jiangsu, Shenzhen, Beijing and other areas. On the one hand, using the survey methods; on the other hand, selecting some of the typical enterprise, choosing the interview form. By these ways, we get more information to provide authentication for the probably assumption test. This research put out 240 questionnaires and recovered 118, furthermore, we screened the returned questionnaires and removed 9 questionnaire items which have missing problems, remaining 109 valid questionnaires, the questionnaire response rate was 45.4%.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cronbach’s α</th>
<th>KMO</th>
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<tbody>
<tr>
<td>CTO External Social Capital</td>
<td>0.879</td>
<td>0.865</td>
</tr>
<tr>
<td>Technological Innovation Performance</td>
<td>0.839</td>
<td>0.808</td>
</tr>
<tr>
<td>CTO Technology Strategy Participation</td>
<td>0.851</td>
<td>0.835</td>
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There are two issues in research need to be resolved, which are the questionnaire's reliability and validity. The results can be seen from Table 1, Cronbach's α of three variables were 0.879, 0.839 and 0.851, which were greater than 0.7, showed high reliability; then using KMO measure for the samples’ data, the paper find that KMO values were 0.865, 0.808 and 0.835, which were greater than 0.7, in line with the validity requirements. The basic sample is shown in Table 2.

<table>
<thead>
<tr>
<th>Basic characterizes</th>
<th>Sample numbers</th>
<th>Percentage</th>
<th>Sex</th>
<th>Sample numbers</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Position CTO</td>
<td>10</td>
<td>9.2%</td>
<td>Male</td>
<td>102</td>
<td>93.6%</td>
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<tr>
<td>(Technical) Vice president</td>
<td>14</td>
<td>12.8%</td>
<td>Female</td>
<td>7</td>
<td>6.4%</td>
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<tr>
<td>Technical Director Profession</td>
<td>32</td>
<td>29.4%</td>
<td>Background</td>
<td></td>
<td></td>
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<tr>
<td>R&amp;D Center Director</td>
<td>12</td>
<td>11.0%</td>
<td>Commerce</td>
<td>4</td>
<td>3.7%</td>
</tr>
<tr>
<td>Total workers</td>
<td>19</td>
<td>17.4%</td>
<td>Engineering</td>
<td>76</td>
<td>69.7%</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
<td>20.2%</td>
<td>Science</td>
<td>29</td>
<td>26.6%</td>
</tr>
<tr>
<td>Age</td>
<td>Arts</td>
<td>0</td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under the age of 30</td>
<td>4</td>
<td>3.7%</td>
<td>Overseas study time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-40 years</td>
<td>65</td>
<td>59.6%</td>
<td>0 years</td>
<td>101</td>
<td>92.7%</td>
</tr>
<tr>
<td>40-50 years</td>
<td>35</td>
<td>32.1%</td>
<td>1-3 years</td>
<td>6</td>
<td>5.5%</td>
</tr>
<tr>
<td>50-60 years</td>
<td>5</td>
<td>4.6%</td>
<td>3-5 years</td>
<td>1</td>
<td>0.9%</td>
</tr>
<tr>
<td>60 and above</td>
<td>0</td>
<td>0.0%</td>
<td>5-10 years</td>
<td>1</td>
<td>0.9%</td>
</tr>
<tr>
<td>Education</td>
<td>Junior college and under ones</td>
<td>11</td>
<td>10.1%</td>
<td>Overseas work time</td>
<td></td>
</tr>
<tr>
<td>Bachelor</td>
<td>55</td>
<td>50.5%</td>
<td>0 year</td>
<td>100</td>
<td>91.7%</td>
</tr>
<tr>
<td>Master</td>
<td>21</td>
<td>19.3%</td>
<td>1-5 years</td>
<td>8</td>
<td>7.3%</td>
</tr>
<tr>
<td>MBA</td>
<td>16</td>
<td>14.7%</td>
<td>5-10 years</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Dr. and above</td>
<td>6</td>
<td>5.5%</td>
<td>10-15 years</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>University type</td>
<td>985</td>
<td>16.5%</td>
<td>Enterprises scale-Employees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>211</td>
<td>37</td>
<td>33.9%</td>
<td>1-9</td>
<td>1</td>
<td>0.9%</td>
</tr>
<tr>
<td>General institution</td>
<td>29</td>
<td>26.6%</td>
<td>10-99</td>
<td>25</td>
<td>22.9%</td>
</tr>
<tr>
<td>Second-level institution</td>
<td>16</td>
<td>14.7%</td>
<td>100-499</td>
<td>44</td>
<td>40.4%</td>
</tr>
<tr>
<td>Third-level institution</td>
<td>9</td>
<td>8.3%</td>
<td>Above 500</td>
<td>39</td>
<td>35.8%</td>
</tr>
<tr>
<td>Working hours in the current industry</td>
<td>Corporate Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 10 years</td>
<td>31</td>
<td>28.4%</td>
<td>1-10</td>
<td>50</td>
<td>45.9%</td>
</tr>
<tr>
<td>10-20 years</td>
<td>62</td>
<td>56.9%</td>
<td>10-20</td>
<td>42</td>
<td>38.5%</td>
</tr>
<tr>
<td>20-30 years</td>
<td>15</td>
<td>13.8%</td>
<td>20-30</td>
<td>9</td>
<td>8.3%</td>
</tr>
<tr>
<td>30-40 years</td>
<td>1</td>
<td>0.9%</td>
<td>30-50</td>
<td>2</td>
<td>1.8%</td>
</tr>
<tr>
<td>Above 40 years</td>
<td>0</td>
<td>0.0%</td>
<td>Above 50 years</td>
<td>6</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

4.2 Variable measurement

(1) Independent Variable: Technological Innovation Performance. When talking about the measurement of the Technological Innovation Performance, for a long time, management and economics mostly research it from the innovation efficiency or innovative angle to measure, which is very single, it exist some defects, and can’t fully ration the status of technological innovation performance. Zhang Fanghua used a multi-issue item to measure, which is from innovation efficiency and innovation angle, both aspects used five questions to measure the enterprise’s technological innovation performance, it accessed many academics’ recognition. This paper follows the measurement system through the following five aspects to measure the Technological Innovation Performance: compared with the major competitions in the domestic, ① the number of new products; ② the number of patent applications; ③ new product output value taking up the total value; ④ the speed of new product development; ⑤ the success rate of innovative products. In operation, the 5-point Likert scale was used to assess these indicators, of which 1 represents very low, and 5 represents very high.
(2) Attributive Variable: CTO External Social Capital. Existing research on social capital mainly from the internal social capital and external social capital two angles to measure, and that there has been some research results available for reference, the measurement of CTO external social capital in this article mainly on its contact operation with external Social capital sources (including customers, suppliers, competitors, government, etc.). In operation, this article reference to the three-dimensional degree pointed out by Nahapiet and Ghoshal's in 1998, which are structure dimension, relational dimension and cognitive dimension. Of which, structural dimension are measured from the following three items: the frequency of contact, the closeness of contact, the number of contact objects; relational dimension are also measured from three items: there exists selfish tendency in the process of the two sides’ contractions, the two sides can cooperate in good faith, the two sides can keep promises; the cognitive dimension includes two items: a common language when contact with each other to communicate effectively, there is a similar link in the value orientation.

(3) Intermediate variables: CTO Technology Strategy participation. Since there is no involvement research on the CTO Technology Strategy, this paper according to Fu Jiaji and other people's research on the division of dimensions of technology strategy, and the CTO's technology strategy in the enterprise behavior is divided into resources, management, relationship these three dimensions. In which resources dimension including four aspects: evaluating the status of their own technical resources, controlling new market by selecting and controlling core technologies, investing more in research and development than its main competitors, focusing on the supplement of core technology and improving the supporting resources; the management dimension conclude three aspects of contents: always testing the development of technology in the industry, actively participating in predicting the technological change tendency, demonstrate in paying attention to the core technology in the application of new products, dedicated to the organize and manage of the whole process of R&D and marketing, relationship dimension includes two aspects: tends to obtain advanced technology from the outside, accurately grasp the technology to market timing.

(4) Control variables: Firm Size, Firm Age, and Type of Enterprise. Nadler and Tushman persist that firm size is an important attribute in effecting corporate behavior and decision-making, a larger companies with more abundant resources, and is more likely to increase research and development efforts to attract partners for technological innovation. In addition, the technological innovation performance may be different as the background may change; firm age and type of enterprise are also important influences to the results of research.

5 Hypothesis Testing

5.1 Correlation Analysis

Table 3 The correlation analysis of CTO external social capital, technology strategy participation and technological innovation performance

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological innovation performance 1</td>
<td>1</td>
<td>0.376***</td>
<td>0.072*</td>
<td>0.298**</td>
<td>0.203</td>
<td>0.305**</td>
<td>-0.079</td>
<td>0.343***</td>
</tr>
<tr>
<td>Structure dimension 2</td>
<td>1</td>
<td>0.586***</td>
<td>0.555***</td>
<td>-0.096</td>
<td>0.035</td>
<td>-0.161</td>
<td>0.654***</td>
<td></td>
</tr>
<tr>
<td>Relationship dimension 3</td>
<td>1</td>
<td>0.714***</td>
<td>-0.146</td>
<td>0.057</td>
<td>-0.282*</td>
<td>0.575***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive dimension 4</td>
<td>1</td>
<td>-0.065</td>
<td>0.151</td>
<td>-0.096</td>
<td>0.383***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm Age 5</td>
<td>1</td>
<td>0.181</td>
<td>0.115</td>
<td>0.135</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm Size 6</td>
<td>1</td>
<td>-0.003</td>
<td>0.334**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Firm 7</td>
<td>1</td>
<td>-0.165</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In order to avoid the interference of multi-collinearity, all of the independent variables and mediating variables were carried out the center treatment before interactive processing. First of all, this research tested the correlation between variables, the results shown in Table 3, studies show that: significant positive correlation were exist between innovation performance and CTO external social capital’s structure dimension, relationship dimension, cognitive dimension, firm size, CTO Technology Strategy participation; CTO technology strategy participation and technological innovation performance, CTO external social capital’s structure dimension, relationship dimension, cognitive dimension and firm size has a significant positive correlation. Thus, the relevant test results show that there was a significant correlation between the main study variables and their dimensions. Thus, this method can be used regression analysis to explore the relationship between the CTO external social capital’s structure dimension, relationship dimension, cognitive dimension, CTO technology strategy participation and technological innovation performance.

5.2 Regression analysis

Table 4 The regression analysis between CTO External Social Capital, Technology Strategy Participation and Technological Innovation Performance

<table>
<thead>
<tr>
<th>Regression method</th>
<th>Multiple Regression</th>
<th>Multiple Regression</th>
<th>Approach levels return Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3 (Step 1)</td>
</tr>
<tr>
<td>Variable</td>
<td>CTO Technology Strategy Participation</td>
<td>Technological Innovation Performance</td>
<td>Technological Innovation Performance</td>
</tr>
<tr>
<td></td>
<td>Beta</td>
<td>t</td>
<td>Beta</td>
</tr>
<tr>
<td>Structure dimension</td>
<td>0.346***</td>
<td>5.879</td>
<td>0.362***</td>
</tr>
<tr>
<td>Relationship dimension</td>
<td>0.407***</td>
<td>4.110</td>
<td>0.593**</td>
</tr>
<tr>
<td>Cognitive dimension</td>
<td>-0.222**</td>
<td>-2.650</td>
<td>0.336*</td>
</tr>
<tr>
<td>CTO Technology Strategy Participation</td>
<td>0.325*</td>
<td>2.112</td>
<td>0.325*</td>
</tr>
<tr>
<td>Firm Scale</td>
<td>0.173</td>
<td>3.953</td>
<td>0.148</td>
</tr>
<tr>
<td>Firm Age</td>
<td>0.006</td>
<td>2.430</td>
<td>0.006</td>
</tr>
<tr>
<td>Type of Firm</td>
<td>0.004</td>
<td>0.123</td>
<td>-0.031</td>
</tr>
<tr>
<td>Model F</td>
<td>20.034***</td>
<td>3.732**</td>
<td>6.014***</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.642</td>
<td>0.178</td>
<td>0.350</td>
</tr>
</tbody>
</table>

Note: * indicates less than 0.05 significance level, ** indicates significance level less than 0.01, *** indicate significance level of less than 0.001.
From Table 4, Model 1 shows the regression of CTO Technology Strategy participation with CTO External Social Capital, by F test, F = 20.034, and F value significance is 0.000; the adjusted R² of Model 1 is 0.610, it means that the predictor variables explained 61.0% of the variance, of which CTO External Social Capital’s Structure dimension, Relationship dimension, Cognitive dimension are more significant influence the CTO Technology Strategy Participation. Meanwhile, the first step of testing mediation effects of CTO Technology Strategy Participation can be passed.

Model 2 indicates the relationship of Technological Innovation Performance and CTO Technology Strategy participation, in which Technological Innovation Performance as the dependent variable, CTO Technology Strategy participation as the explanatory variable, From Model 2 we can see that the Beta value of Technical Innovation Performance and CTO Technology Strategy Participation is 0.325, which is a positive value, and reached a significant level (p <0.05), hypothesis H₂ is verified. Meanwhile, the mediation effects of CTO Technology Strategy Participation can be passed in the second step.

Model 3 and Model 4 belong to the two steps of return regression. Model 3 was on the return regression between Technological Innovation Performance and External Social Capital, Control Variable, the F value is 6.014, F value is significant to 0.000 by F test; the adjusted R² in model 3 is 0.292, means that all predictor variables explained 29.2 % of the variance, in which CTO structure dimension of the external social capital (Beta = 0.362), CTO relationship dimension of external social capital (Beta = 0.593), CTO cognitive dimension of external social capital (Beta = 0.336), firm size (Beta = 0.175) have more significant impacts on Technological Innovation Performance. Model 3 test results show that the hypothesis H₃a, H₃b, H₃c is supported, that is CTO external social capital’s structure dimension, relationship dimension, cognitive dimension have positive influence on the technological innovation performance. Meanwhile, CTO Technology Strategy Participation’s mediating effect which as the third test step is passed.

Model 4 shows the technological innovation performance as control variable, and its regression analysis for CTO Technology Strategy Participation, CTO external social capital’s structure dimension, relationship dimension, cognitive dimension, F = 5.326, F value is significant to 0.000 by F test; the adjusted R² for Model 4 is 0.293, means that all predictor variables explained 29.3% of the variance, in which CTO structure dimension of the external social capital (Beta = 0.283), CTO relationship dimension of external social capital (Beta = 0.501), CTO cognitive dimension of external social capital (Beta = 0.386) have the more significant impact on Technological Innovation Performance. Model 4 test results indicate that, after joining the variable of CTO Technology Strategy Participation. CTO external social capital structure dimension remains to be a significant factor, but its coefficient (Beta = 0.283) is decreased than the third step of the coefficient (Beta = 0.362), so CTO Technology Strategy Participation play a partial intermediary role in the relationship between CTO External Social Capital and Technological Innovation Performance ,assuming that H₃a is verified. In addition, the coefficient of CTO External Social Capital’s relationship dimension in the Model 4 is also significant, but its coefficient (Beta = 0.501) decreased a little than the third step of the coefficient (Beta = 0.593), so CTO Technology Strategy Participation plays a intermediary role in the relationship between CTO External Social Capital’s relationship dimension and Technological Innovation Performance, assuming that H₃b is verified. However, the relationship between CTO External Social Capital’s Cognitive dimension and Technological Innovation Performance in the Model 3 and Model 4 are significant, but its coefficient did not decrease (0.336 <0.386), so the hypothesis of CTO Technology Strategy Participation play an intermediary role in the relationship of CTO External Social Capital’s Cognitive dimension and Technological Innovation Performance has not been verified.

6 Conclusion and Discussion
This study explored the influential process of various dimensions of CTO External Social Capital to Technological Innovation Performance. Although there were many discussions individual social capital and technology innovation performance previously, but most are more concerned about social capital in entrepreneur and its relationship with technological innovation performance, and there was little in-depth analysis on the CTO’s who is the head of enterprise technical aspects social capital and its
relationship with innovation performance, in addition, although some researchers believe that the CTO external social capital will have some relations to technological innovation performance, meanwhile, CTO Technology Strategy Participation will have some media-impact on the relationship, but the empirical research with mechanism of the model which was lacked. In this study, the CTO Technology Strategy Participation as an intermediary variable, to explore each dimensions of CTO External Social Capital’s influence process to the Technological Innovation Performance, and also the research verified some of the early theoretical discussion.

This study used multiple regression method to test the relationship between CTO Technology Strategy Participation and Technological Innovation Performance, and concluded that they are positively related. CTO need to play an important role in strategy decision process, on the one hand CTO can use their own technical knowledge for the executive team, especially the CEO to provide information when making strategic decisions, based on the high degree of participation in technology strategic decision-making of enterprise, CTO play the role of technical consulting role, so as to promote enterprises to develop effective technology strategies, and play a catalytic role to technology innovation performance. On the other hand, as the head of technology management, CTO participation in technology strategy decision-making in a high degree, and also it promote business strategy matching technology strategy to ensure that enterprise technology strategy and business strategy in the same direction, leading to a positively output, to win favorable business performance for the output.

In addition, this study used hierarchical regression, first test the relationship between various dimensions of CTO external social capital and technological innovation performance, the results showed that the relevant research hypotheses have received verification, that is to say the CTO external social capital and technology innovation performance is to the relevant. CTO’s responsibilities have changed, as the head of internal management, not only he need to address internal issues related to technology management, and also it promote business strategy matching technology strategy to ensure that enterprise technology strategy and business strategy in the same direction, leading to a positively output, to win favorable business performance for the output. Meanwhile, as an important decisions manager in technical information, CTO must take external and external trends into account, and are willing to understand the field of innovation, to establish and make good use of its external social capital.

Further, the mediating effect of CTO Technology Strategy Participation was tested; the conclusion was that CTO Technology Strategy Participation play an intermediary role in the relationship of CTO External Social Capital’s Structure Dimension, Relationship Dimension with Technological Innovation Performance, CTO Technology Strategy Participation play an intermediary role in these two processes. Usually long-term exchanges and cooperation with external social capital, and the same norms, obligations, expectations, recognition, trust and trustworthiness can be formed between each other; these relationships may lead to a positive and cooperative behavior, which can win CTO more resources, especially knowledge and information on technical innovation, these are the basis of companies develop technology strategy, and further the development of a clear future direction, market positioning, while the higher level of CTO Technology Strategy Participation ensure they can inject information into high-level decision, and also it is the basis ensure that enterprise technology strategy and corporate strategy match each other, the matching relationship for technological innovation performance has got a lot of argument. In this study, the research hypothesis on that CTO Technology Strategy Participation play an intermediary role in the relationship of CTO external social capital cognitive dimension and technological innovation performance has not been verified, the reason may include the following: CTO external social capital cognitive dimension described that when contact with external social capital, they can have a common language to communicate effectively, and existence the similar values, all of these stability relationships usually need CTO and external social capital have a long-term run communication, but for our high Technology companies, CTO position usually Established very late and usually more concerned their relationships in internal R&D management when established, the redefinition of CTO responsibilities, and focus on the communication between CTO and the external body (such as universities, research institutions, customers , suppliers, and government, etc.) and make CTO into
senior executives, so that CTO can play the role in technology strategy, and make a clear strategic role of the CTO's responsibilities are set as CTO’s responsibility are things in recent years, even for some high technology companies, these are still not classified as a CTO's job duties, which may lead to a big difference between CTOs’ responsibilities in each enterprises, the truly relationship between CTO and external has not been established, and CTO still did not receive the actual position in technology strategy and top management, thus, the research hypothesis for CTO Technology Strategy Participation play an intermediary role between CTO external of social capital cognitive dimension and technological innovation performance is difficult to obtain verified. In addition, the number of the sample and the representativeness and validity of individual scales of measurement may also lead to deviation reasons for the research.

In summary, the results of this study show that, for China's high-tech enterprises, CTO external social capital’s structure dimension, relationship dimension, cognitive dimension, CTO technology strategy participation will have a significant impact on enterprises’ technological innovation performance. These all described that in the internal of Chinese high-tech enterprise, CTO's role is changing, and in the future development, on the one hand, from outside the enterprise concerned, CTO need to be more focused on the main contact with the external and to establish common vision awareness with them; on the other hand, considered from the internal enterprise, CTO need to highly participate in strategic decision-making, in order to continuously enhance his direct and indirect effects on the strategic business decisions. Further, CTO Technology Strategy participation is also play an intermediary role in the relationship of CTO external social capital structure dimension and technological innovation performance. Helping us to understand the influence means of CTO external social capital and technological innovation performance, so as to make CTO play an important role in China’s high-tech enterprises, and to make these enterprises sustainable competitive advantage through technical innovation. Furthermore, the paper also proposed that in the current high-tech enterprises, for the responsibilities of CTO is not clear enough; CTO’s utility did not get enough use, so companies need to focus on the definition of CTO responsibilities in the future, to ensure that CTO can play a greater role in the enterprises’ internal and external circumstance.

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