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Outbound Open Innovation for Enhanced Innovation Performance: An Empirical Study based on BTB Enterprises in China

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Abstract

Open Innovation gains a wide spread attention in technology management research in recent years. Because existing research about the relationship between outbound open innovation and innovation performance is limited and context factors are ignored in existing research and based on Chesbrough's open innovation model and theory of enterprise competence, this study introduces enterprise competence and knowledge spillovers into the field of outbound open innovation, explores their moderated roles between open innovation and innovation performance. We use high-tech firms as research sample to test the hypothesis that we proposed and find that: (1) outbound open innovation has a positive effect on innovation performance; (2) both enterprise competence and knowledge spillovers moderate the relationship between outbound open innovation and innovation performance. These conclusions have important implications for the development and application of open innovation theory.

Keywords: *open innovation, innovation performance, enterprise competence, knowledge spillovers*

1. Introduction

Since 1980s, with the rise of global manufacturing, the relations among enterprises have gradually changed from competition to cooperation-competition, and more and more enterprises regard the external obtainment of knowledge resources as a major way of technological innovation applied to the practice process of business strategy [1].What is corresponding to it is that enterprises gradually make the activities about making the existing knowledge externally commercialized active. These commercial activities not only include profitable activities such as selling non-core technology, but also include strategic activities such as patent sharing and strategic alliances building [2]. Chesbrough(2006) [3] called such activities as outbound open innovation of the enterprise, which is one of the main innovation paradigm with the framework of open innovation.

Due to the non-competitive of knowledge [4], many enterprises choose to conduct both inbound open innovation and outbound open innovation at the same time [2], and regard outbound open innovation as a complement to the innovation process of inbound open innovation [5], and then it is just the process that reflects the commercial value [6]. However, the existing empirical studies about the effect on enterprises that outbound open innovation had mostly see "enterprise performance" as the dependent variable [7], and the study about the relations between outbound open innovation and enterprise performance

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is relatively inadequate[8].Innovation performance is not only embodied in the development speed, quantity and level of new product, but also can be reflected by the evaluation of the innovation market performance [9], and thus it can better reflect the performance level of outbound open innovation under open innovation background for enterprises [8].

Meanwhile, due to high idiosyncratic of knowledge [10], enterprises often cannot successfully expand the way of outbound open innovation because of high cost of technology transfer in practice [11]. In this regard, some scholars point out that it should be explored costs reduction mechanism from the organizational capacity building [12] [13].On the basis of studies of Lorenzoni together with Lipparini (1999) [14]and Fleming together with Waguespack (2007) [15], Lichtenthaler and Lichtenthaler (2009) [16] firstly introduced the concept of relational capability into the framework of open innovation. Further, Gao *et al* (2010) [17] thought that the enterprise should strengthen the construction of the enterprise competence to better benefit from open innovation due to basic environment changes of the organization brought by open innovation. Regrettably, it lacks of the support of follow-empirical research.

In addition, the success of enterprise adopting outbound open innovation model is also affected by situational factors [7]. Studies show that the industries with a high degree of knowledge richness tend to provide more opportunities to gain a competitive advantage for the enterprise in the industry than the industries with low degree of knowledge richness [18]. Meagher and Rogers (2004) [19] attributed the phenomenon to positive role play by knowledge spillovers. Network spillover belongs to the external effect of the economics, and derives from the interactive process such as the meeting, outsourcing, cooperation among members of the industry [9]. This process is beneficial to improve the degree and efficiency of knowledge dissemination across the enterprise [20], and can provide more opportunities for enterprises' successful practice of outbound open innovation.

Based on the above analysis, the study takes samples of the Chinese enterprises, and firstly examines the impact which outbound open innovation has on innovation performance, and then researches the regulatory mechanism that enterprise competence and network spillover of the enterprise operate in the relations between outbound open innovation and innovation performance in order to promote the development and application of outbound open innovation mode under Chinese situations.

2. Literature Review and Research Hypothesis

2.1. Outbound Open Innovation and Innovation Performance

Outbound open innovation refers to the process of the enterprise's commercializing own knowledge resources externally [2], and is a way of value innovation across the border [21]. Although the academia has an insufficient attention to inbound open innovation relative to outbound open innovation [11] and think there exists risks such as the core knowledge leaked and weakening the competition in the process of conducting outbound open innovation for the enterprise [22], in the practice, more and more enterprises ,including IBM, Texas instruments and Dow Chemical Company ,gain great profits from licensing technology to other enterprises every year [23]. In our country, the rapid development of technology trading market from the side also reflects the popularity of outbound open innovation among enterprises: the national technology market clinch a deal technology contract 282242 items, and a deal amount 643.707 billion yuan in 2012, increasing by 10.07% and 35.13% than year-on-year of 2011 [24]. Outbound open innovation injects liquidity into the gradual adoption and application among enterprises in technology trading market, and has a positive impact on itself development[25]. As the technical exchanges and cooperation between the international countries increasingly

close, the commercial value of outbound open innovation is gradually revealed.

Many case studies show that outbound open innovation can promote enterprise innovation level [23-26]. Lichtenthaler (2008)[25], from three aspects of product orientation, technology orientation as well as the overall performance, summarizes the strategic value of outbound open innovation, and think outbound open innovation plays a positive role in building industry standards, developing new market, obtaining external technology as well as constructing enterprise network, which not only can reserve external knowledge resources [27], but also lays the foundation to keep enterprises' competitive advantage [11]. For example, Tesla Motors open all patents to encourage all automakers to focus on and use the patent technology, aiming to form a industry standard based on Tesla's electric vehicle technology and expand the enterprise's green electric vehicle innovation and market space [8].Kulvonen (2011) [11] from the perspective of knowledge management, expounded the strategic value of outbound open innovation and thought it when outbound open innovation is in the process of knowledge exchange, the enterprise, on the one hand ,can capture and learn new knowledge to supplement their own weak technology link, and on the other hand may extend product life cycle by the establishment of industry standards so as to keep the enterprise's core technology in the leading position in the industry, which provide safeguard for follow-up new product development. Based on the above analysis, the paper put forward the assumption:

H1: Outbound open innovation has a positive influence on innovation performance

2.2. The Regulation of Enterprise Enterprise Competence

Due to high idiosyncratic of knowledge [10], the complexity which appeared when the enterprise is on technical trading in process of outbound open innovation, is far greater than the general product or service [28]. At the same time, because of the constraints of some problems such as high transaction costs, the specificity [29-], outbound open innovation tend to be restricted in a closed enterprise network environment rather than the open knowledge market, which is easy to cause sub-optimal choice between partners [31], and affects performance level of outbound open innovation.

Enterprise enterprise competence is the ability to effectively manage external resources [32], and is a reflection of dynamic capabilities [33], having a positive effect on the promotion of enterprise' innovation performance [34]. Studies have shown that the enterprises with high enterprise competence ,on the one hand, can establish correlations with more enterprises by improving enterprise network configuration [35] to strengthen knowledge transfer between members of the network [36]; one the other hand, it can build more partnerships with complementary effect, improving interaction efficiency and exerting synergy [9]. In addition, enterprise enterprise competence can help enterprises improve the discovery of the opportunities for joining in new corporate networks, removing the suboptimal choice problem brought by the enterprise limited in a network [37]. So in theory it can be inferred that enterprise enterprise competence plays an active role between outbound open innovation and innovation performance. Based on the above analysis, the paper put forward the assumption:

H2: The stronger enterprise enterprise competence is, the greater impact outbound open innovation has on innovation performance.

2.3. The Regulation of Knowledge Spillovers

Knowledge spillovers refer to the extensive flow of knowledge in enterprise networks [38]. In the spillover process, knowledge spreads through processes such as selling technology licensing, outsourcing, cooperative R & D among network members [39]. The higher knowledge spillovers degree is, the lower the difficulty of enterprises' cross-border search is [40], and the higher the rate of enterprise technology external transfer is .Sisodiya *et al* (2013) [20] thought that in the enterprise' external information search

process, knowledge spillovers can provide a target-rich context to support this process. High degree of network spillover can help enterprises acquire more knowledge and the switch opportunities, thereby increasing the success probability of outbound open innovation, and then enhancing innovation performance. Based on the above analysis, the paper put forward the assumption:

H3: The higher knowledge spillovers degree is, the greater impact outbound open innovation has on innovation performance.

Summing up the variables relationship expressed by the above three assumptions, this paper summarizes as shown in Figure 1:

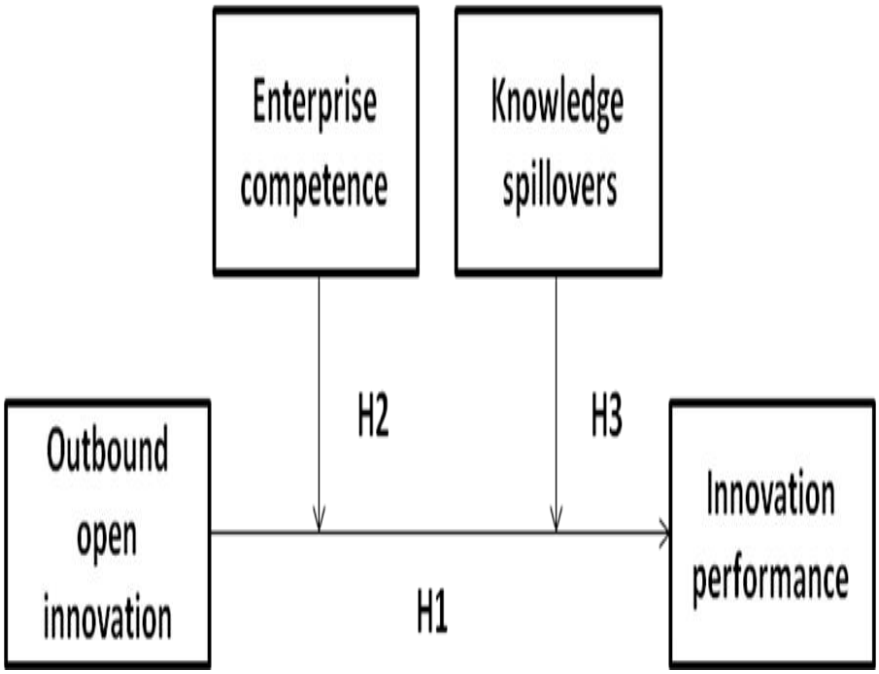

Figure 1. The Research Framework of this Paper

3. Methods

3.1. Sample and Data Collection

This paper mainly uses the subjective measurement method to reflect the important role of outbound open innovation in enterprises' strategy practice. Since September 2014, we started data collection work. In order to verify the proposed hypotheses, we mainly choose industry with high degree of knowledge richness, and enterprises which are facing pressure of NPD continually. In sample selection process, therefore, this paper selected high-tech enterprises, including integrated circuit, new display, computer and software development, consumer electronics and communications equipment industries from Beijing Zhongguancun Science Park, Shanghai Zhangjiang Hi-tech Park, Suzhou Industrial Park, Tianjin Economic-Technological Development Area and Shenzhen high-tech industrial park. Enterprises we selected are all belong to electronic information industry categories. Relying on the common method of exiting research [42], enterprises we selected should meet requirements that firm's size is more than 10 people and firm's age is more than three years.

In the process of data collecting , We sent 350 questionnaires in this survey, recovered 243 questionnaires, and 211 questionnaires are valid, the recovery rate is 69%, effective rate is 60%. Among the research enterprises, there are 29 integrated circuit enterprises, accounting for 13.74% of the total; there are 51 new display enterprises, accounting

24.17% of the total; there are 69 computer and software development companies, accounting for 32.7% of total; there are 40 consumer electronics companies, accounting for 18.96% of total; there are 22 communication equipment companies, accounting for 10.43% of total. Enterprise personnel scale in 10 to 50 people accounts for 3.79%, 51 to 100 (19.43%), 101-500 (50.71%), 501-1000 (16.59%), more than 1001 people accounts for 9.48%. Fixed number of year of the enterprise was established in 3 to 5 years (5.69%), 6 to 10 years (24.17%), 11 to 15 years (37.44%), 15 to 20 years (21.33%), 21 years (11.37%).

Main part of the questionnaire part adopts Likert seven-point scoring method, respondents score items due to the description of the variable. Among them, 1 means "completely disagree", 7 means "completely agree".

3.2. Variables

Outbound open innovation scale is based on the research of Hung and Chou (2013) [41], the scale sets outbound open innovation as a single dimension variable, including four items. KMO value of outbound open innovation scale item is 0.811, chi-square value of Bartlett sphere test is 301.62 (degrees of freedom = 6, at 0.001 significant level). According to principal component analysis (PCA), we extract one characteristic value greater than 1 factor, consistent with reference set, the cumulative variance contribution rate of 66.528%. Reliability is 0.831, Confirmatory factor test shows that the scale have a good fitting validity (chi square/df = 2.41, GFI = 2.41, RMSEA = 0.089, CFI = 0.980, TLI = 0.951). The exploratory factor analysis of outbound open innovation will be seen in Table 1.

Table 1. Exploratory Factor Analysis of Outbound Open Innovation

Item Brief	Component
We sell technology as a major business activity.	.818
We welcome other enterprises to buy and use our technology.	.808
We have a dedicated team to operate the enterprise's knowledge assets such as the sale, outward technology licensing, *etc*.	.823
We actively sell the patent products and do after-sales service well, so that these technical knowledge is better absorbed, applied and expanded by external enterprises.	.813

Enterprise competence is based on the research of Torkkeli *et al* (2012) [34], the scale sets enterprise competence as a single dimension variable, including 6 items. KMO value of enterprise competence scale item is 0.912, chi-square value of Bartlett sphere test is 580.18 (degrees of freedom = 45, at 0.001 significant level). According to principal component analysis (PCA), we extract one characteristic value greater than 1 factor, consistent with reference set, the cumulative variance contribution rate of 51.701%. Reliability is 0.860, Confirmatory factor test shows that the scale have a good fitting validity (chi square/df = 1.159, GFI = 0.970, RMSEA = 0.037, CFI = 0.988, TLI = 0.998). The exploratory factor analysis of enterprise competence will be seen in Table 2.

Knowledge spillovers is based on the research of Sisodiya *et al* (2013) [20], the scale sets knowledge spillovers as a single dimension variable, including 5 items. KMO value of enterprise competence scale item is 0.824, chi-square value of Bartlett sphere test is 346.52 (degrees of freedom = 10, at 0.001 significant level). According to principal component analysis (PCA), we extract one characteristic value greater than 1 factor, consistent with reference set, the cumulative variance contribution rate of 58.63%. Reliability is 0.822, Confirmatory factor test shows that the scale have a good fitting validity (chi square/df = 2.747, GFI = 0.975, RMSEA = 0.091, CFI = 0.974, TLI = 0.949). The exploratory factor analysis of knowledge spillovers will be seen in Table 3.

Innovation performance is based on the research of Parida *et al* (2012) [9], the scale

sets innovation performance as a single dimension variable, including 5 items. KMO value of innovation performance scale item is 0.844, chi-square value of Bartlett sphere test is 509.97 (degrees of freedom = 15, at 0.001 significant level). According to principal component analysis (PCA), we extract one characteristic value greater than 1 factor, consistent with reference set, the cumulative variance contribution rate of 58.461%. Reliability is 0.857, Confirmatory factor test shows that the scale have a good fitting validity (chi square/df = 4.35, GFI = 0.944, RMSEA = 0.126, CFI = 0.940, TLI = 0.900). The exploratory factor analysis of innovation performance will be seen in Table 4.

Table 2. Exploratory Factor Analysis of Enterprise Enterprise Competence

Item Brief	Component
The enterprise knows that some of its own resources are needed by other enterprises.	.783
The enterprise gets more new partners through cooperation.	.868
The enterprise often evaluates the practical effect of the cooperation with the partners.	.834
The enterprise often discusses the progress of cooperation relationship with partners.	.750
The enterprise continuously deepens and improves the relationship with partners	.774
The enterprise is good at effectively integrating technologies	.845

Table 3. Exploratory Factor Analysis of Knowledge Spillovers

Item Brief	Component
The enterprise can effectively expand enterprise's knowledge and technology resources by reading and following the industry white paper.	.793
The enterprise can effectively expand enterprise's knowledge and technology resources by participating in industry meetings and communicating with other enterprises actively.	.761
The enterprise can effectively expand enterprise's knowledge and technology resources by learning from other business failures.	.783
The enterprise can effectively expand enterprise's knowledge and technology resources by other enterprises interaction in the industry.	.786
The enterprise can effectively expand enterprise's knowledge and technology resources by learning professional knowledge.	.792

Table 4. Exploratory Factor Analysis of Innovation Performance

Item Brief	Component
We are often in the lead to push out new products / services in the industry.	.801
We are often in the lead to apply new technology in the industry.	.799
We have a good market reaction to the improvement and innovation of new products.	.742
Our products include the first-class technology and processes.	.736
Compared with peers, the success rate of our product innovation is higher.	.707
Compared with peers, we have more patents, or copyright.	.798

4. Analyses and Findings

Relying on the research of Sisodiya *et al* (2013) [20] and Hung and Chou (2013) [43], we select size and scale of companies as control variables, which are used the most frequently in strategic management field [43]. Table 5 shows the descriptive statistics including correlation matrix and reliability figures for all variables in this study. Correlation coefficient between outbound open innovation and innovation performance is 0.676, at 0.001 level, Hypothesis 1 is preliminary supported.

Table 5. Descriptive Statistics and Correlation between each Variable

	Mean	SD	1	2	3	4	5
Firm size	3.09	0.95					
Firm age	3.14	1.05	0.355***				
OOI	5.50	0.95	0.037	0.043			
EC	5.82	0.79	0.028	0.085	0.638***		
KP	5.65	0.78	−0.043	0.049	0.694***	0.847***	
IP	5.61	0.79	0.119*	0.061	0.676***	0.733***	0.558***

***p＜0.001,**p＜0.01,*p＜0.05，(two-tailed test; N=211);OOI: outbound open innovation, EC: enterprise competence, KP: knowledge spillovers, IP: innovation performance

Hypothesis 2 and Hypothesis 3 suggest that enterprise competence and knowledge spillovers positively moderate the relationship between outbound open innovation and innovation performance respectively. To test whether the ordinary least square (OLS) regression can be used to test the hypotheses, this study checked for the normal distribution assumptions, homogeneity of variance assumption, and multi-collinearity. To avoid possible multi-collinearity on the interaction term in the regression analysis, the constructs on OI dimensions and moderators were centered, which allowed variance inflation factors(VIF) values on all independent variables to fall below 4. The results indicate adequate OLS regression in both hypotheses testing and results interpretation.

Table6 shows the hierarchical regression results using innovation performance as the dependent variable. Control variables and moderators were entered in model 1, which adequately explains a significant amount of the variance (R^2=0.55, p<0.001). In model 2, outbound open innovation was entered where the variable accounts for an additional amount of the variance (ΔR^2=0.04, p<0.001). The standardized beta coefficient shows outbound open innovation to be positively and significantly related to innovation performance (β=0.26, p<0.001). Hypothesis 1 is supported.

Based on previous research, this study applied mean centering procedures and separately entered each interaction term into the main effects model [7] and [41], In model 3, the interaction term of outbound open innovation and enterprise competence was entered in model 2, and the results shows that interaction term of outbound open innovation and enterprise competence is positively and significantly related to firm performance (β=0.41, p<0.001), andΔR^2=0.1(p＜0.001).This finding supports Hypothesis 2. In model 4, the interaction term of outbound open innovation and knowledge spillovers was entered in model 2, and the results shows that interaction term of outbound open innovation and knowledge spillovers is positively and significantly related to firm performance (β=0.39, p<0.001), and ΔR^2=0.07(p ＜ 0.001).This finding supports Hypothesis 3. Interactive effects between outbound open innovation and enterprise competence and between outbound open innovation and knowledge spillovers are showed in Figure 2 and Figure 3 respectively.

Table 6. Results of Multiple Regression Analysis

	Model 1		Model 2		Model 3		Model 4	
Firm size	0.14*	(2.64)	0.12*	(2.40)	0.08+	(1.77)	0.13*	(2.46)
Firm age	-0.04	(-0.83)	-0.04	(-0.73)	-0.04	(-0.61)	-0.01	(-0.32)
EC	0.63***	(6.84)	0.39***	(4.67)	0.41***	(5.05)	0.33***	(3.86)
KP	0.31**	(2.76)	0.16*	(1.98)	0.04	(0.59)	0.16*	(2.01)
OOI			0.27***	(4.33)	0.32***	(4.01)	0.23***	(3.58)
OOI×EC					0.41***	(8.41)		
OOI×KP							0.39***	(6.01)
R^2	0.55		0.59		0.68		0.66	
ΔR^2			0.04***		0.1***		0.07***	
F	59.97***		58.13***		65.67***		72.08***	

All beta coefficients are standardized, with t-values in parentheses.
p＜0.001,p＜0.01,*p＜0.05，+p<0.1(two-tailed test; N=211);OOI: outbound open innovation, EC: enterprise competence, KP: knowledge spillovers, IP: innovation performance

5. Conclusions and Discussion

On the basis of collating existing documents, this paper discusses the influence mechanism of outbound open innovation for innovation performance from the perspective, and taking it into account that whether impact intensity of outbound open innovation for innovation performance will change under the different levels of knowledge spillovers conditions.

First, without considering the scene settings, outbound open innovation has a significant and positive impact on innovation performance. Currently the academic results about the impact outbound open innovation has on the enterprise has not yet formed a coincident conclusion, but its positive side has been generally recognized by academics [7]. Although in the outbound open innovation process the enterprise increases the risk of leakage of core technology [22] and even competitive advantage is affected, the conclusions of this study shows that from the overall point of view, outbound open innovation has a positive effect on enterprise' development, consistent with the research conclusion of Spithoven *et al.* (2011) [8] and Lichtenthaler (2009) [7], *etc*, providing support for the enterprise to practice outbound open innovation. Thus, at the international level with the background of broad information flow and shrinking social learning cycle, enterprises should divert attention from stock of knowledge to how to improve the flow of knowledge, and enhance corporate innovation performance through more participation in inter-organizational exchange of knowledge and resources share. Meanwhile, the increasing popularity of inter-enterprises technology's external licensing in recent years fully demonstrates that outbound open innovation plays a important role in extending product life cycle and establishing technical standards and other aspects [11], and it is a necessary condition for enterprises to obtain value from their technology. Therefore, in the process of open innovation, enterprises should not only focus on the inbound open innovation based on external resources acquisition, but should be fully aware of the positive role of outbound open innovation which is regarded as complementary strategies of inbound open innovation rather than alternative strategies and make full use of them.

Second, enterprises enterprise competence plays a positive role in regulating the

relationship between outbound open innovation and innovation performance. In outbound open innovation process, managers need to develop the appropriate skills to support the process to exert smoothly, while the skills are entirely different with inner-enterprise learning, innovation and other skills. Although the existing studies have realized mechanisms problems for discussing outbound open innovation from the capacity perspective, they explore the building problem of organization capacity in outbound open innovation process mostly from innovation capacity [16], absorption capacity [8], learning capacity [17] and other aspects, ignoring that the organizational basis changes brought by outbound open innovation require an external network governance competence. Therefore, this study hypothesized and verified that in outbound open innovation process, the stronger the corporate enterprise competence is, the more obvious the enhancing role of the outbound open innovation for innovation performance is, making up for the shortcomings of the existing researches and supporting for the idea that Gao *et al* (2010) [17] proposed to regard enterprise enterprise competence as a key element for successful practice of enterprise's open innovation.

Third, knowledge spillovers play a positive role in regulating the relationship between outbound open innovation and innovation performance. The reason why existing discussions about outbound open innovation performance mechanisms appear contradictory is because they ignore an important reason of the external situational factors study for enterprise. This study finds that outbound open innovation has a positive impact on innovation performance, and as knowledge spillovers degree is greater, the impact will be significantly enhanced. So the conclusion is a complement to existing outbound open innovative research.

This paper takes Chinese high-tech enterprises as samples and test outbound open innovation performance mechanism, providing Chinese experienced data for the combination of outbound open innovation and capability theory, and is also a complement to the existing open innovation theory. In business management practices, technology sale is often seen as a non-planned business activity, lacking of strategic considerations. With the international technical exchanges and cooperation increasingly close, strategic value of outbound open innovation gradually prominent. Therefore, it is necessary for Chinese enterprises to pay attention to strategy application of outbound open innovation and strengthen knowledge flow management, at the time of achieving technology innovation, and to make efforts to promote technical standards and make use of own advantages choosing and joining in more enterprise networks with complementary nature, and then enhance their own value.

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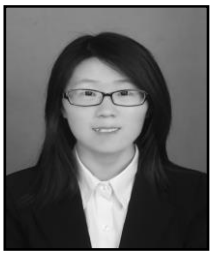

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