

THE EMPIRICAL STUDY OF RELATIONSHIP FACTORS AND COOPERATIVE R&D PERFORMANCE--BASED ON THE PERSPECTIVE OF COOPERATION EXPERIENCE AND DATA IN CHINA

LI SHUN-CAI

Huazhong University of Science and Technology, School of Management, P.R. China
895525315@qq.com

TAN PAN-PAN

Huazhong University of Science and Technology, School of Management, P.R. China
tpp9007@126.com

LIU FENG-ZHU

Huazhong University of Science and Technology, School of Management, P.R. China
liufengzhu@163.com

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ABSTRACT

Many scholars have studied how to improve cooperative R&D performance from the perspective of relationship factors. Former research has ignored the dynamic development of relationship and cooperation experience's effect on the relationship between relationship factors and cooperative R&D performance. This paper divides relationship factors into relationship capital and relationship maintenance, caring about the development and maintenance of the relationship. Then the paper studies the relationship of relationship capital, relationship maintenance and cooperative R&D performance. Besides, cooperation experience has been put into the model to see whether it will make affects. The paper uses SEM and Multiple-Group Analysis to conduct an empirical analysis based on data of 172 companies in China. The results show that: relationship capital has significant positive effects on relationship maintenance and cooperative R&D performance; relationship maintenance has no significant positive effects on cooperative R&D performance; cooperation experience makes significant differences between different groups as the regulating variable.

Key words: relationship capital; relationship maintenance; cooperative R&D performance; cooperation experience; multiple-group analysis

INTRODUCTION

As the main body of innovation, single enterprise carries out innovation activities in the form of R&D cooperation to reduce risks and access needed resources. Whereas enterprises may have conflicts caused by different culture, values and so on. R&D cooperation in practice is not satisfying. Scholars have studied cooperative R&D performance from the "soft" aspects with the development of social capital theory. Robson et al (2006) studied corporate innovation and its performance form the perspective of organizational behavior. Krause et al (2007) explored the reasons affecting cooperative performance, including relationship capital and maintenance. But the researches ignore the dynamic development of the relationship. Relationship maintenance should also be considered into the study because it will make influences on cooperative performance during the process of R&D cooperation. Besides, whether the partner has cooperation with the enterprise has been

ignored. There was no consistent conclusion on cooperation experience's effect on cooperative performance (Wang F, Dang XH, 2013), so it is exploratory to consider cooperation experience in the study.

China is a country with the special culture, and "GuanXi" is very important. Perks (2009) deemed informal social system affects cooperative innovation through relationship based on China's unique social and cultural background. So it is meaningful to study relationship capital, relationship maintenance, R&D cooperation performance and cooperation experience, which helps for improving cooperative R&D performance.

LITERATURE REVIEW AND HYPOTHESES

i. Relationship capital and relationship maintenance

Robson et al (2006) considered relationship capital as unique relationship resources, which contain trust, commitment and so on. There was no standard definition of relationship capital, but trust and commitment were the important part of relationship capital (Cullen et al, 2000). This paper deems relationship capital as close relations of cooperation involved in the level of organization and individual, including two dimensions of trust and commitment. Problems are inevitable, especially conflicts of sharing and synergy during the cooperation. Relationship conflict is negatively related to the team innovation performance. That conflicts of cooperation were solved efficiently is a key to the success of R&D cooperation (Xiang CC& Long LR, 2010). The best way to reduce conflicts is to pay attention to relationship maintenance. Xue et al (2010) regarded relationship maintenance as whether the enterprise solves problems and conflicts with a positive and cooperative attitude.

In enterprises' R&D cooperation, trust is the expectation of partner's behaviors and confidence to accept each other. CHai et al (2011) believed trust was the basis of the cooperation relationship, which could not only improve the quality of information exchange but also reduce the uncertainty or opportunism. Trust made cooperation more open and transparent, which laid beneficial foundations for solving problems together and prompted partners to offer help (S H & W L, 2009). Trust makes contributions to the development of cooperation relationship. In enterprises' R&D cooperation, commitment was the attitudes and behaviors to continued cooperation relationship, acceptance and willingness to invest resources (Sarkar et al, 2001). Cullen et al (2000) divided commitment into calculation commitment and attitude commitment, and the later meant commitment of emotions. Commitment of emotions comes from good interaction of R&D cooperation enterprises, and they would strive to maintain this relationship (Yan et al, 2010). Lanscastre and Lages (2006) believed partners involved in commitment would build, maintain, strengthen and deepen contacts by R&D cooperation. Commitment helps for deepening cooperation relation, solving problems and reducing conflicts.

In conclusion, the paper puts forward

Hypothesis 1a: trust in the relationship capital can improve the relationship maintenance of R&D cooperation

Hypothesis 1b: commitment in the relationship capital can improve the relationship maintenance of R&D cooperation

ii. Relationship capital and cooperative R&D performance

In management research, performance is often taken as the result variable to measure factors' influence and effect. Relationship capital provided foundations for getting innovation resources, which could also reduce costs and opportunism and finally improve cooperative R&D performance (Wittman, 2009). Cooperative R&D performance can be improved by relationship capital mainly through trust and commitment.

Trust was the guarantee of effective cooperation innovation, which would strengthen the knowledge sharing and transfer, promote knowledge integration and bring about improvement of cooperative innovation performance (H LJ, 2011). Fawcett (2012) demonstrated how trust affected innovation and performance by a dynamic system model. Song J (2013) found out trust among organizations helped for improving the satisfaction and performance of cooperation. The development of cooperation organizations is through commitment to relationship, which shows as the investment of specialized assets and trust in the R&D cooperation. Peng ZL and He PX (2014) found out commitment helped to improve the cooperation relationship and had significant positive influence on cooperation performance. Zhang XM, Chen W (2012) found out relation commitment had significant positive influence on cooperation performance. Commitment can increase the certainty and effectiveness of resource exchange, reduce risks and costs, and is conducive to the success of R&D cooperation.

Hypothesis 2a: trust in the relationship capital can improve the performance of R&D cooperation

Hypothesis 2b: commitment in the relationship capital can improve the performance of R&D cooperation

iii. Relationship maintenance and cooperative R&D performance

The nature of R&D cooperation is creating new technology with other enterprises, so effective knowledge exchange and learning are needed between enterprises. Tacit knowledge can not be gained from market transactions, which must be got through effective knowledge exchange of enterprises. It is inevitable of conflicts between the enterprises of R&D cooperation because of cultural differences, knowledge and technology distance.

To reduce conflicts' effects on cooperation relationship stability, partners should solve problems and decrease conflicts actively for the achievement of cooperation goals (Kandemir, 2006). R&D cooperation enterprises with good relationship maintenance ability would strengthen the resource sharing and exchange and help for common action. Nonaka & Takeuchi (1995) deemed common action could increase the exchange of complex, tacit knowledge and information. Good relationship maintenance will lead to the establishment of a common language, the tacit understanding, normalization and internalization during the process. Besides, relationship maintenance makes contributions to coordination behavior which will finally promote knowledge innovation and cooperation performance.

Hypothesis 3: relationship maintenance can improve the performance of R&D cooperation

iv. Cooperation experience

Cooperation experience was a special relationship between enterprises, which could be divided into proprietary cooperation experience with the same partners and general cooperation experience with any partners (Hoang & Rothaermel, 2005). Most researchers take cooperation experience as

one dimensional concept and indicate it with a single index of cooperation times. Cooperation experience in the paper is proprietary cooperation experience and measured by proprietary cooperation experience. One enterprise can predict the behavior of partners in the future and risk appetite on the basis of the former cooperation. It would enhance sustainable development of relation, improve the acceptance of partners and the willingness to input resources (Lancaster & Lages, 2006). Wang F and Dang XH (2013) found there was inconsistent conclusion of relationship between cooperation experience and innovation performance. Cooperation experience is one factor affecting cooperative innovation performance. Relation factors make significant affects on the performance of R&D cooperation. Then what role does cooperation experience play in their relationship?

In this paper we introduce a model for exploring the relationship of relationship capital, relationship maintenance and cooperative R&D performance in China. Besides, cooperation experience has been introduced to see its role in the model. It can be seen in Figure 1.

METHODOLOGY

i. Structure equation model (SEM) and Multiple-group analysis

Structural equation model (SEM) is a blend of the factor analysis and path analysis of multivariate statistical techniques. Its strength lies in the quantitative study of interaction relationship between multivariate. Multiple-group structure equation model analysis is used to evaluate whether the model with special sample is suitable to other samples, that is to say Hypothesis model is the same in different samples. Multiple-group structure equation model analysis in the paper takes cooperation experience as the moderating variable.

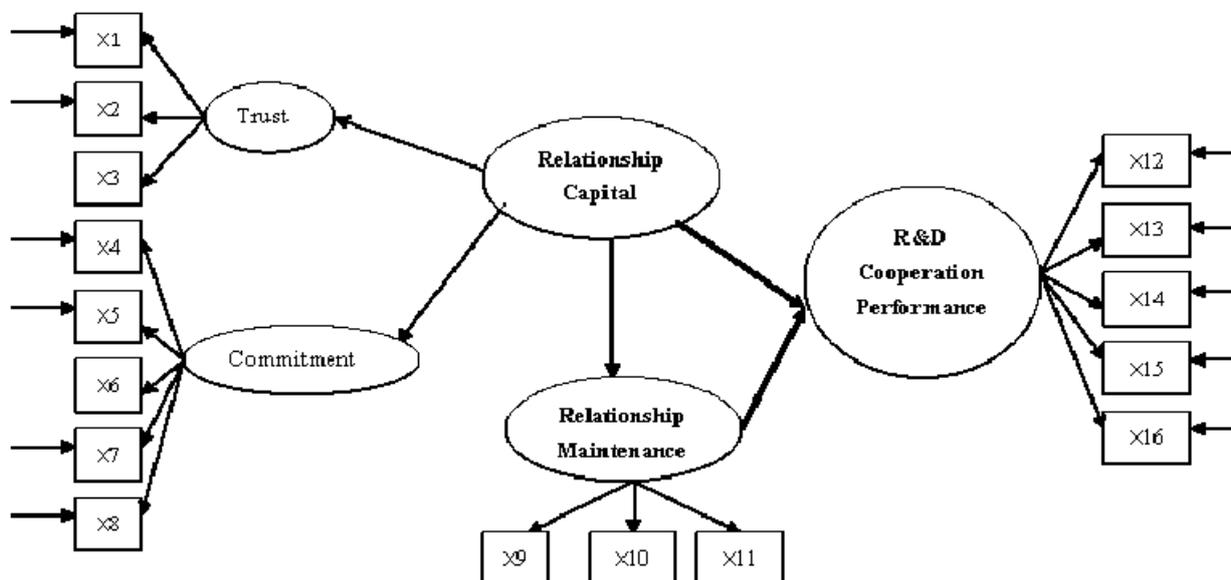


Figure1: SEM model

ii. Variance

The paper has four Latent variables and all are measured by Likert scale seven ("1" represents strongly disagree, "7" represents very agree). The paper adopts maturity scale and makes necessary

changes to improve the credibility of the data collection. The detailed measurements of variances can be seen in the table 1.

Relationship capital contains trust and commitment. Trust could be measured by three observation variables after a content analysis and factor analysis, which was derived from Morgan & Hunt (1994). Relationship maintenance was whether the enterprise solved problems and conflicts with a positive and cooperative attitude, which could be measured by three observation variables from Das & Teng (2001), Xue et al (2010). Considering the availability of the data, the paper uses subjective dimensions which are derived from Lin YP (2001) and Ling L (2011) from the perspective of one specific enterprise. It can be measured by five observation variables. As moderating variable, cooperation experience is measured by the former cooperation times (0= no cooperation before, 1= have cooperation before). The measurement is adapted to test whether both partners have cooperation or not before the R&D cooperation.

iii. Sample

The data of the paper is gained by the questionnaire survey by using paper and electronic forms. The objects of this questionnaire survey mainly are enterprises' head or R&D department's director. The data collected comes from Hubei province, Henan province and some other cities and provinces because of the availability. Every research object answers the questionnaire by choosing one partner they believe important during the R&D cooperation now or before. 350 questionnaires have been sent out and 201 questionnaires have been recycled. Finally we get 172 effective questionnaires after excluding 29 ones with too much wrong answers or invalid answers. The recovery rate and effective rate of these questionnaires reach 57% and 57% respectively.

FINDINGS

I. Reliability and validity

Reliability can be measured by Cronbach's alpha coefficient. After internal consistency analysis, the Cronbach's alpha coefficients of trust, commitment, relationship maintenance and cooperative R&D performance are all greater than 0.7. Besides, all CR values are more than 0.8 and all AVE values are more than 0.5. All above show the scale has good reliability. The questionnaire is of considerable content validity because of it is developed by previous literature through a modest change. After confirmatory factor analysis, standardized factor loading coefficients ranges from 0.545 to 0.865 with strong statistical significance ($P < 0.01$). The fit of the model as a whole is better ($\chi^2 / df=2.49$; RMSEA=0.66 ; CFI=0.91 ; IFI=0.91 ; GFI=0.85). All above show the scale has good validity. The specific information is concluded in Table 1 as follows.

Tab 1: Items, reliability and validity of the scales

Variables and items	Factor loading	AVE	Cronbach's α	CR
trust				
the staffs of the partner are very honest to us	0.738	0.542	0.763	0.777
we feel we are fairly treated by the partner during	0.840			

Variables and items	Factor loading	AVE	Cronbach's α	CR
cooperation				
we believe the decisions of the partner will not damage our interests	0.613			
commitment				
We have invested production equipments or tools with strong specificity	0.545			
we have conducted specialized research and development for needed technology	0.717			
both partners have invested enough resources	0.865	0.553	0.873	0.858
the head of both partners attach great importance to the cooperation relations and provide lots of support	0.780			
both partners plan to do on the cooperation relationship	0.772			
Relationship maintenance				
we have not passed the buck for arising problems during the cooperation	0.790			
we can provide partner supports to solve problems	0.836	0.686	0.888	0.868
we solve problems and conflicts with a positive and cooperative attitude	0.858			
cooperative R&D performance				
both partners have learned relevant skills and expertise	0.796			
both partners have got the needed resources	0.715	0.543	0.894	0.855
both partners have reduced R&D risks	0.677			
both partners have reduced R&D costs	0.631			
both partners are satisfied with R&D cooperation	0.845			

ii. The verifications of variable relationship

The output of the model is showed in Tab2. The standardized path coefficient of trust to relationship maintenance, cooperative R&D performance is 0.256, 0.319 respectively. It is assumed that H1a, H2a can be verified because of reaching a significant level. H1b、H2b are verified as well for the same reasons, whereas H3 will not be accepted because of insignificant level. In the short term, cooperative enterprise will pretend to take responsibility, solve conflicts and problems positively.

But when the cooperation comes to a certain time and extent, the relationship maintenance will fall into the bottleneck and partners may do nothing. Even partners' willingness and action are unified at the beginning, but it will not assure the same in the future. The expectation of co-members will change, which will finally be expressed in attitudes and acts. So the above may be the accounts for insignificant relationship between relationship maintenance and cooperative R&D performance.

Tab2: the verification results of the hypotheses

hypothesis	Standardized path coefficient	Value of P	conclusion
H1a: trust → relationship maintenance	0.256	***	acceptance
H1b: commitment → relationship maintenance	0.897	***	acceptance
H2a: trust → R&D cooperation performance	0.319	***	acceptance
H2b: commitment → R&D cooperation performance	0.848	***	acceptance
H3: relationship maintenance → R&D cooperation performance	-0.01	0.959	refusal

notes : *** represents $P < 0.001$, ** represents $P < 0.01$, * represents $P < 0.05$

For more intuitive understanding of the direct, indirect and total effects of the structural model between latent variables, the results are summarized in Table 3. It shows the most influential effect on R&D cooperation performance is commitment, followed by trust. The most influential effect on relationship maintenance is commitment. Relationship maintenance's indirect effect on R&D cooperation performance is negative. So to improve R&D cooperation performance, commitment is the priority to be improved. Not only the input of special equipments and other resources but also high attention and support are needed to improve commitment. More important is the willingness and behavior to continue the R&D cooperation, actively solving problems, making the partnership get better maintenance and development.

Tab 3: Direct effect, indirect effect the total effect between latent variables

Relationship of variables	Direct effect	Indirect effect	total effect
trust → relationship maintenance	0.256	—	0.256
Commitment → relationship maintenance	0.897	—	0.897
trust → R&D cooperation performance	0.319	-0.03	0.316
commitment → R&D cooperation performance	0.848	-0.09	0.839
Relationship maintenance → R&D cooperation performance	-0.01	—	-0.01

Notes: total effect= direct effect + indirect effect

iii. Multiple-group analysis based on cooperation experience

The data is cultivated by AMOS 17.0 and the results are concluded in table 4. CFI is between 0.86 and 0.899, which is higher than 0.80 (acceptable), PNFI is between 0.560 and 0.704, which is all higher than the standard value of 0.5; RMSEA values are about 0.80. Therefore, the multi-group structural equation model can better fit with observed data.

Tab 4: the estimated results of group structure equation model based on the cooperation experience

	H1a	H1b	H2a	H2b	H3
have cooperation before	0.442**	0.962**	-0.395	-0.341	1.291*
Have no cooperation before	0.214**	0.928***	0.442***	1.355***	-0.539

The results of multi-group structural model equation (as shown in Table 4) show that previous cooperation has significant influence on the relationship between trust and R&D cooperation Performance, whereas the previous non-cooperation is not significant. The main reason may be that previously cooperation brings about higher expectation and trust of partner's taking no opportunistic behavior, meeting its obligations and responsibilities. In contrast, non-cooperation before will affects expectation during the process. Cooperation has significant influence on the relationship between commitment and R&D cooperation Performance, whereas the previous non-cooperation is not significant. Previous cooperation produces higher cognitive acceptance of partner. Partners without previous cooperation may adjust their attitudes, acts and reduce commitment. Cooperation has insignificant influence on the relationship between relationship maintenance and R&D cooperation Performance, whereas the previous non-cooperation is significant. Partners without previous cooperation will try to maintain the relationship well at the beginning of the cooperation. The effect of having previous cooperation is more significant on the relationship between commitment and relationship maintenance. The best explanation is that the acceptance of partner's values and expectation for reaching cooperation are higher.

CONCLUSION

The paper has verified the model of relationship capital, relationship maintenance and cooperative R&D performance by empirical research of 172 enterprises. Relationship capital's effect on relationship maintenance and cooperative R&D performance is significant, whereas relationship maintenance's effect on cooperative R&D performance is not significant. Different group's effect is not the same after multi-group analysis. The differences can be expressed from the perspective of cooperation time, extent and different measures to partners according to whether there is previous inter-firm cooperation: relationship maintenance should be paid enough attention during R&D process to improve performance because they have formed good relationship capital; partners without previous cooperation need more interactions to increase relationship capital to reduce cognitive differences and finally reach cooperative goals and performance.

The conclusions of the paper have theoretical and practical meaning to some extent, but there are still some insufficient. First, the data of questionnaire survey is collected only from one partner of

the R&D cooperation, which may make affects on conclusions; second, the paper uses cross-sectional data, which can not reflect the dynamic development of variables. So further research can enhance the measurement of time-series data of various factors to further understand the interaction between variables and get more accurate conclusions; In addition, there is no comparison of cooperation experience's direct effect and moderate effect and cooperation experience is measured only by cooperation times. Finally, cross-organizational learning, knowledge management, etc. can be put into the model to make the model more perfect and research deeper.

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