Research on the Influencing Factors of Diversification of Innovation Sources

Tie Wei1,*, Mei Yang2,b, Yingge Gong1,c and Linling Xie1,d

1Business School, Guangxi University, Nanning, China, 530004
2Nanning College for Vocational Technology, Nanning, China, 530008

*Corresponding author e-mail: weitie@gxu.edu.cn
b228027588@qq.com, c842916027@qq.com, d531412143@qq.com

Abstract. In this paper, we explore the influencing factors of the decentralization of innovation sources from the overall social level. More specifically, the work intends to examine how the social environment (intellectual property judicial protection, Internet, knowledge environment, Salary Income), technical characteristics (technical opportunities, industrial agglomeration, technology spillovers, absorptive capacity, technological preference) and innovation rent (transfer of technology, commercialization) affect the decentralization of innovation sources through patent data. Results show that the effect of Salary Income, technological opportunities, technological absorptive capacity and innovation rent on the decentralization of the overall source of innovation are significant.

1 Introduction
Companies gradually tend to adopt open innovation to gain competitive advantage in the market [1] [2]. With the improvement of ICT technology and education, increasing organizations and stakeholders put forward new ideas in various ways. Even a large number of non-R&D employees and the general public can participate in innovation activities through the Internet platform like Maker, Wikipedia. This has led to the development of an open innovation model that is popular and decentralized [3] [4]. At the same time, it also brings more challenges for policy makers and business managers. Therefore, it is necessary to explore what factors influence the decentralized development of innovation sources.

Most of the research on sources of innovation focused on its impact on innovation activities. Lusch et al. studied the role of employee in innovation [5]. Nicolette et al. and Li et al. discussed the role of innovation sources such as suppliers in innovation [6] [7]. Grabher and Ibert studied on the effect of community on innovative profit [8]. Hippel [3], Bilgram [9] and Song et al. [10] [11] proposed the trend of popularization of innovation and believed that with the development of network communication technology, the source of innovation is not limited to the physical boundaries of the organization, and its degree of dispersion can be expanded with the creativity and imagination of human beings. However, the existing literature still lacks research on the factors affecting the decentralization of innovation sources. Therefore, this paper aims to solve the problem of the influencing factors of innovation sources that have been neglected in the existing research and provides a theoretical basis for the in-depth exploration of the root causes and general laws of the decentralized development of innovation sources.
2 Theoretical Hypotheses
This paper studies the factors influencing diversification of innovation sources from three aspects, i.e., social environment, technical characteristics and innovation tent.

2.1 Social Environment
No matter what type of innovation source, its production and development cannot be separated from a certain social environment. We put forward the hypothesis that social environment factors influence the decentralization of innovation sources from the four levels of the entire society -- the level of intellectual property protection, the level of knowledge accumulation, the level of Internet development and the Salary Income.

2.1.1 The Level of Intellectual Property Protection
Innovation theory has always regarded intellectual property protection as one of the important factors of innovation activities [12]. For innovative activities, intellectual property theft, counterfeiting and other infringements will lead to the waste of investment and R&D resources. Therefore, a society with better intellectual property protection promotes mass innovation. Therefore, the following hypotheses are considered.

\[ H1: \text{the higher the level of intellectual property protection is, the higher the degree of diversification of the source of innovation is.} \]

2.1.2 The Degree of Knowledge accumulation
Innovation is a speculative process to solve a certain technical problem to obtain a solution, and this process depends on knowledge elements [13]. The generation of innovation requires the accumulation of knowledge elements, and the degree of social knowledge accumulation will also affect the degree of popularization of innovation. Social knowledge accumulation stimulating innovation origins firstly from the higher education, secondly from the more basic field of science and technology. Therefore, the following hypotheses are considered.

\[ H2: \text{the higher the degree of knowledge is accumulating, the higher the degree of diversification of the source of innovation is.} \]

\[ H2a: \text{the level of higher education has a positive impact on the degree of diversification of the source of innovation.} \]

\[ H2b: \text{the degree of popularization of science and technology has a positive impact on the degree of diversification of the source of innovation.} \]

2.1.3 The Development Level of The Internet
The development of the Internet provides a platform for the public to assist innovation, and network-centric innovation has gradually become a new innovation model. The main body of innovation has been expanded unprecedentedly, and public collaboration and innovation have become possible. Therefore, the development and popularization of the Internet has increased the possibility of public access to knowledge information. Therefore, the following hypotheses are considered.

\[ H3: \text{the higher the development level of the Internet is, the higher the degree of diversification of the source of innovation is.} \]

2.1.4 The Level of Salary Income
Incentive theory believes that people's needs determine the motivation and motivation also dominates the behavior. Therefore, the needs of employees, especially senior executives, will lead the direction of the entire company. Edwards and Eisenberger thought that we can stimulate employees' innovative behavior [14] through monetary reward. Therefore, the following hypotheses are considered.

\[ H4: \text{the higher the level of income is paid, the higher the degree of diversification of the source of innovation is.} \]
2.2 Industrial Features

In the open innovation, the innovation activity in different industries also has different characteristics. Therefore, we also discuss the factors influencing the source of innovation from the perspective of industrial characteristics.

2.2.1 The degree of industrial agglomeration

Industrial agglomeration makes knowledge and information transmission more convenient, thereby reducing the risk of technological innovation. Tacit knowledge transfer and dissemination expand the agglomeration innovation network and promote innovation output. Therefore, the following hypotheses are considered.

H5a: the greater the degree of industrial specialization is, the higher the degree of diversification of the source of innovation is.

H5b: the greater the degree of industrial diversification is, the higher the degree of diversification of the source of innovation is.

2.2.2 The Degree of Industrial Technology Spillover

When technology spillover effects occur, competitors in the industry can get innovation related know-how or technical information at very low cost. Specifically, technology spillovers provide opportunities for potential innovators, enabling potential innovators to use low-cost technical information to innovate, thus becoming a new participant in innovation activities. Therefore, the following hypotheses are considered.

H6: the greater the degree of industrial technology spillovers is, the higher the degree of diversification of the source of innovation is.

2.2.3 Industrial Technology Opportunities

Klevorick et al. put forward the concept of technology opportunity to reflect the difficulty of technological progress in different industries [14]. The industries with higher technological opportunities will accumulate their knowledge faster and the technology will update faster. This will make it easier to produce advanced technologies and achieve breakthrough innovations. For intra-industry organizations, especially those chasing higher innovation returns, they are more willing to continue technological innovation activities in the technical field of high-tech opportunities. Therefore, the following hypotheses are considered.

H7: the higher the opportunity for industrial technology is, the greater the degree of dispersion of the source of innovation is.

2.2.4 Industrial Technology Difficulty

If the technology within an industry is more difficult to overcome, the newer organizations or individuals will need to have higher technological standards to enter the field. As a result, the amount of investment in innovation has increased correspondingly, and the more difficult it is for potential innovation sources to enter the field. Therefore, the following hypotheses are considered.

H8: the more difficult the industrial technology is, the smaller the degree of diversification of the source of innovation is.

2.2.5 Industrial Technology Absorptive Capacity

Technology absorptive capacity refers to the ability of enterprises to identify, absorb and utilize external knowledge and technology [15]. Cohen and Levin demonstrated the impact of absorptive capacity on the efficiency of new product development processes from the perspective of innovation efficiency [15]. The stronger the technology absorption capacity, the higher the acceptance of innovators, which is more conducive to the entry of external innovation sources. Therefore, the following hypotheses are considered.

H9a: The stronger the industry’s ability to acquire and digest knowledge (PAC), the higher the degree of decentralization of sources of innovation.

H9b: The stronger the industry’s ability to transform and apply knowledge (RAC), the greater the
2.3 Innovation Rent

Hippel believed that the diversity of innovation sources comes from innovative rents, that is, the excess interest that the innovation subject obtains due to the monopoly right of innovation for a certain period of time is the innovation rent [5]. Different potential innovation subject's difference in the expected return of innovation leads to the difference of the innovation rent, which leads to the diversification of innovation sources. Therefore, the following hypotheses are considered.

H10a: the higher the profit of technology transfer, the higher the dispersion of innovation sources.
H10b: the higher the return of technology commercialization, the higher the dispersion of sources of innovation.

3 Research Design

3.1 Variable Design

The variables and measurement methods are shown in Table 1.

| Type           | Name                                      | Measurement Method                          |
|---------------|-------------------------------------------|---------------------------------------------|
| Explained     | the Degree of Diversification of Innovation Sources | Number of Patent Applicants (Ln)            |
| IPR Protection Level | IPR Civil Case Closing Amount (Ln)       |                                             |
| Higher Education Level | Number of College, Undergraduate and Graduate Students (Ln) |                                             |
| The Popularity of Science and Technology | National Science Association Science Lecture Number (Ln) |                                             |
| Internet Development Level | The Number of Computers Per 100 Households (Ln) |                                             |
| Salary Income level | Average Salary Income of Employed Persons (Ln) |                                             |
| Industrial Specialization Degree of Agglomeration | Industry Employment / Total Employment |                                             |
| Industry Diversification Degree of Agglomeration | The Sum of the Squares of the Degree of Specialization of All Industries (Foreign Technology Introduction Costs + Domestic Technologies) |                                             |
| Exploratory   | Industrial Technology Spillover           | Transaction Amount) / Technological Activities Internal Expenditure |
| Industrial Technology Opportunities | Patent Application (Ln) |                                             |
| Industrial Technical Difficulty | Invention Application / Patent Application Total |                                             |
| Industry Access and Digestion Knowledge (PAC) | R&D Personnel Full-time Equivalent (Ln) |                                             |
| Industrial Transformation and Applied Knowledge (RAC) | Invention Patent Grant (Ln) |                                             |
| Technology Transfer Profits | Technical Market Transaction Volume (Ln) |                                             |
| Technology Commercialization Profits | New Product Sales Income (Ln) |                                             |

3.2 Data Sources

The patent-related data in this paper comes from the time series data of patent information retrieval. Other relevant indicator data are from China Statistical Yearbook, China Science and Technology Statistical Yearbook, and White Paper on Intellectual Property from 1992 to 2016.

3.3 Model

This paper uses multivariate linear regression method to establish the estimation model to explore the factors influencing diversification of innovation sources. According to the hypothesis, a regression model consisting of social environment variables, industry characteristic variables, innovative rent variables and time parameters is established as follows.

\[
Y_i = c + \sum_{i}^{n} a_i X_{i,i} + \sum_{j}^{m} \beta_j Z_{j,i} + \sum_{k}^{l} \gamma_k W_{k,t} + \epsilon_{i,j,t}
\]

where \(Y_i\) represents the degree of innovation diversification, \(X_{i,i}\) (i=1, 2, ..., n) represents the social environment variable, \(Z_{j,i}\) (j=1, 2, ..., m) is the industry characteristic variable, \(W_{k,t}\) (k=1, 2, ..., l) is the innovative rent variable, and t is the annual time. In order to avoid multiple collinearity and influence the correct reflection of the estimation result on the relationship between the explanatory variable and the explanatory variable, a stepwise regression analysis method was used to regression the variable, eliminating the collinearity variable.

For the regression analysis of each influencing factor, the linear correlation between each
The fitting between the explanatory variable and the interpreted variable is better, and there is a significant linear relationship. Only the coefficient of regression between the technical overflow variable and the innovation source is less than 0.8. According to the above regression analysis results, the technical spillover factors are eliminated, and a multivariate linear regression model with time series is established by stepwise regression according to the hypothesis. The regression analysis results are shown in Table 3.

### Table 3: The Regression Analysis Results

| Explanatory variables | Coefficient | Standard |
|-----------------------|-------------|----------|
| Social Environment    | 1.054612**  | 0.333879 |
| Salary Income         | -0.675020*** (-6.054419) | 0.109825 |
| Commercialization     | 0.594980*** (9.022627) | 0.066964 |
| Technology transfer   | -0.428489* (-2.004276) | 0.212263 |
| Technical Opportunities | 0.647084*** (5.066928) | 0.128629 |
| Absorption of Technology | -0.243496 (-2.004276) | 0.066964 |

Note: * indicates a significant level at 10% level, ** indicates a significant level at 5%, *** indicates a significant level at 1%.

The stepwise regression analysis of the model, the regression results of the relationship between the explanatory variables and the dispersion of the innovation source are shown in the Table 3. The regression model has a higher overall degree of fit, with a coefficient of determination of 0.998979. The regression model test results show that the model DW value is within the decision interval without autocorrelation, and there is no autocorrelation in the regression model. Therefore, the model passes the DW test.

The H7, H10a, H10b was significant at the 1% level. The H4 is significant at the 5% level, and the correlation coefficient between the salary income and the decentralization of sources of innovation is the largest, which shows that the two have a very significant positive relationship. The H9a was
significant at the 10% level. The other explanatory variables are not significant and have been eliminated in the stepwise regression. The insignificant cause is the existence of multicollinearity.

4 Conclusions

From the above studies, we verified H4, H7, H9a, H10a and H10a. Therefore, we draw the following conclusions:

(1) Social environment has a significant impact on the decentralization of innovation sources. The higher the overall salary level, the higher the employee's enthusiasm for work and the more able to help the organization achieve technological innovation, the more dispersed the sources of innovation.

(2) The technical features have a significant effect on the decentralization of innovation sources, which means that higher innovation returns are possible. The more able to attract innovative entities to participate in technological innovation activities, the more dispersed the source of innovation.

(3) The impact of innovative rents on the decentralization of innovation sources is significant. The greater the gains from technology transfer, the more active the technical market activities, the more they can stimulate the innovative enthusiasm of potential innovation entities, and the more dispersed the sources of innovation.

Acknowledgement

This work was supported by the National Natural Science Foundation of China (No.715620001).

References

[1] Chesbrough H. Open Innovation, the New Imperative for Creating and Profiting from Technology[M]. Boston, Harvard business school press, 2003.

[2] Chesbrough H. Open Innovation, the New Imperative for Creating and Profiting from Technology[M]. Boston, Harvard business school press, 2003.

[3] Hippel E V. Democratization of innovation[M]. Boston, MIT press.2005.

[4] Hippel, E V. The Source of Innovation. Oxford University Press, New York, 1988.

[5] Lusch R F, Vargo S L, O’Brien M. Competing through service: insights from service-dominant logic[J]. Journal of Retailing,2007,83(1):5-18

[6] Nicolette L, Christian B, Arjan W. Coordinating supplier involvement in product development projects: a differentiated coordination typology[J]. R&D Management,2006, 36(1):55-65.

[7] Li Y Y, Yun J D. Management S O. "Goodness" Evaluation of Comprehensive Indicator System Construction[J]. Journal of Wuhan University of Technology, 2010.

[8] Grabher G, Ibert O. Distance as asset? Knowledge collaboration in hybrid virtual communities [J]. J. Econ. Geogr,2014,14(1),97-123.

[9] Bilgram V, Brem A, Voigt K. User-centric innovation in new product development[J]. International Journal of Innovation management, 2008, 12(3): 419-458.

[10] Song G, Ji Y, Tang Q, et al. Innovation Mode of Living Lab and Its Enlightenment[J]. Scientific Management Research, 2008, 62:4-7.

[11] Song G, Zhang N. Innovation 2.0: Democratizing Innovation in Knowledge Society[J]. China Soft Science, 2009, 45(10):60-66.

[12] Chen,Y, Puttitanun,T. Intellectual Property Rights and Innovation in Developing Countries[J]. Journal of Development Economics, 2005,78:474-493.

[13] Liu W P. On the Knowledge Base of Human Innovation Activities[J]. Journal of Social Science of Hunan Normal University, 2014.

[14] Edwards M R. Measuring creativity at work: Developing a reward for creativity policy[J]. Journal of Creative Behavior ,1989,23(1):26-37.

[15] Eisenberger R, Haskings F, Gambleton P. Promised reward and creativity: Effects of prior experience[J]. Journal of Experimental Social Psychology ,1999,(3):308-325.