AN EFFECT OF EXISTING KNOWLEDGE ASSETS TO INBOUND/OUTBOUND DISRUPTIVE INNOVATION



Chun-Pei Lin

College of Business Administration,
East Business Management Research Center,
Huaqiao University, Quanzhou, China

Yi-Bin Li

College of Business Administration,
East Business Management Research Center,
Huaqiao University, Quanzhou, China



Chuan-Peng Yu

School of Economics and Commerce,
South China University of Technology,
Guangzhou, China

Innovations are an essential key factor in the history of technology development. Past research on innovation focused more on the innovation behavior of technology, but seldom described the knowledge assets. The effect of knowledge assets attribute and results on disruptive innovation is therefore regarded as the research topic in this study, where disruptive innovation is divided into outbound and inbound to combine combination-embeddedness and major business specificity of knowledge assets as the research model. Manufacturing enterprises in China were proceeded the questionnaire survey, and 173 valid copies are collected. The empirical analysis shows that combination-embeddedness of knowledge assets has significantly positive effects on major business specificity and outbound innovation of an enterprise but reveals remarkably negative effects on inbound innovation. Enterprises are suggested to constantly accumulate knowledge assets with low major business specificity before disruptive innovation in order to reduce ineffective inbound innovation.

Key Words: knowledge assets' combination-embeddedness, knowledge assets' application-specificity for main business, outbound and inbound disruptive innovation

Introduction

Current enterprises are facing the pressure of constant innovation, especially the industries with short product life cycle. Such pressure appears particularly obviously in hi-

On the contrary, such new knowledge is correlated knowledge derived from current knowledge bases, and new products are the outcome of current knowledge-based innovation applied to different industries. Moreover, outbound disruptive innovation often originates from the new application of current technology to other markets, and knowledge and skills in inbound disruptive innovation often reveals larger differences or conflict from current unique capabilities of enterprise. In this case, as considered in this study the higher combination-embeddedness of knowledge assets would generate the organizational inertia promoting an enterprise to focus on current knowledge-based reproduction and cross-industry application and effectively enhance the outbound disruptive innovation, but not inbound disruptive innovation. Accordingly, H2 that combination-embeddedness of knowledge assets reveals significantly positive effects on outbound disruptive innovation and H3 that combination-embeddedness of knowledge assets shows remarkably negative effects on inbound disruptive innovation are proposed in this study.

Knowledge assets are intangible and specific assets (Williamson, 1985). Williamson (1975, 1985) defined major business specificity of knowledge assets as a type of knowledge assets being able to be reallocated in other alternative businesses without sacrificing the productive value. It was essentially a locking effect (Fitzroy & Mueller, 1984), i.e. knowledge assets being constantly reinforced to lock the existing knowledge assets of an enterprise and developing along the directions related to the major business, once major business specificity of knowledge assets was confirmed. When an enterprise attempts to apply such knowledge assets to other business fields, it would be extremely difficult or its economic value would be reduced.

According to Path Dependence Theory, once economic, social, or technological systems enter certain path, they would be constantly reinforced under the habitual function and locked on the specific development path (Davis, 1988). Locking effect of major business specificity of knowledge assets indeed is a kind of path dependence and would affect the innovation activity of an enterprise. Major business specificity of knowledge assets could assist enterprises in continuously acquiring of exclusive advantages on the major business and such unique advantage would guide enterprises to invest in more resources and energy to develop innovation activities related to the major business.

Furthermore, knowledge assets applicability is a critical factor in enterprises developing innovation management strategies (Allarakhia & Walsh, 2011; Di Guardo & Harrigan, 2015). Major business specificity of knowledge assets enhances the applicability to the major business (Ratinho, Harms & Walsh, 2015) and further promotes enterprises developing innovation activities related to the major business. Certainly, such innovation activities would promote the core technology of the major business being applied to different fields to further promote the outbound disruptive innovation. Nevertheless, the higher development degree of major business specificity of knowledge assets would reinforce the path dependence and possible result in the core competence becoming rigid in the major business and being trapped by familiarity, maturity, and propinquity to ignore and even refuse the

disruptive innovation opportunity of nibbling current major business market shares (Levinthal & March, 1993; Wu & Haak, 2013). For this reason, H4 that major business specificity of knowledge assets shows positive effects on outbound disruptive innovation and H5 that major business specificity of knowledge assets presents negative effects on inbound disruptive innovation are proposed in this study.

Research design

Data collection and sample situation

Questionnaire survey is utilized in this study for collecting data. Technology supervisors and middle and high-level managers (vice presidents or general managers), who mainly engage in product research and development, market monitoring, and product strategy development and are familiar with the product innovation of enterprises, of manufacturing enterprises in China were surveyed. Total 360 copies of questionnair are distributed, and 173 valid copies are proceeded. It is found that the percentage of males (53.8%) is slightly higher than females (46.2%), and most of them are middle managers (67.6%), followed by high-level managers (28.9%). Most (126) surveyed enterprises (72.9%) are established below 10-15 years ago, 114 enterprises (65.9%) have more than 300 employees, and most (142) enterprises are private-owned (82.1%). Besides, such enterprises mainly distribute in specific and general equipment manufacturing industry (12.7%), computer, communication, and other electronic equipment manufacturing industry (19.1%), automobile manufacturing industry (12.1%), chemical material and chemical product manufacturing industry (9.2%), and electrical machinery and equipment manufacturing industry (15.6%), and other manufacturing industry appears less than 5%.

Measurement of variables and reliability and validity analysis

Combination-embeddedness of knowledge assets aims to measure the degree of knowledge rooting in internal human-instrument-task of an organization and the complexity of networks. Such an idea and the scale are revised based on Cummings (2002) and combined with Chinese culture. Four questions like “Competitors could hardly acquire the technology skills of the company by field observation and learning” and “Competitors could hardly acquire the technology skills of the company by studying the production equipment” are covered, with Cronbach’s α is 0.806. Major business specificity of knowledge assets intends to measure the degree of existing knowledge assets of an enterprise specifically service current major business. By referring to the idea proposed by Cable & De Rue (2002) and “demand—supply” & “demand—capability”, 5 questions are designed, e.g. “The major business of an enterprise provide large opportunities for the application of existing knowledge assets” and “The existing knowledge assets of an enterprise significantly contribute to the development of the major business”, with Cronbach’s α appears 0.772. The

outbound and inbound disruptive innovation scales are referred to the research of Christensen (1997). Outbound disruptive innovation contains disruptive innovation aiming at new markets and competitors, with 7 measurement questions, e.g. “Comapny often develops disruptive products aiming at brand-new markets” and “Comapny often introduces disruptive products aiming at competitor markets”, with Cronbach’s α reveals 0.856 and 0.711. Inbound disruptive innovation includes 3 measurement questions, e.g. “Developed disruptive products reduce the market shares of existing products of an enterprise” and “Developed disruptive products present alternation of existing products of an enterprise”, with Cronbach’s α 0.772.

For the accuracy and reliability, EFA is applied to test the construct validity of the scales. The KMO value of the 19 measuring items shows 0.752 and Barlett test of sphericity Chi-Square appears 1378.183 (degree of freedom 171), achieving the significance that Factor Analyis is suitable as there are common factors between correlation matrices. 5 factors are extracted with Factor Analysis, including new market targeted disruptive innovation, major business specificity of knowledge assets, combination-embeddedness of knowledge assets, inbound disruptive innovation, and competitor market targeted disruptive innovation. What is more, common method variance (CMV) of Harman’s one-factor test data reveals 5 factors extracted with Principal Component Analysis and the total variance 66.03%. A factor shows 23.53%, not reaching a half of the total variance, presenting that one factor does not explain most variance. The common method variance of the research data is properly controlled.

Empirical result and analysis

Correlation Analysis

The mean, standard deviation, and correlation coefficient of variables in this study are listed in Tab. 1, from which combination-embeddedness of knowledge assets presents notably positive correlations with major business specificity ($r=.188$, $p<.05$) that H1 is supported, combination-embeddedness shows remarakbly positive correlations with outbound disruptive innovation ($r=.182$, $p<.05$) that H2 is supported, and major business specificity presents positive correlations with outbound disruptive innovation ($r=.265$, $p<.01$) but reveals negative correlations with inbound disruptive innovation ($r=-.328$, $p<.01$). Such results found the basis for successive research.

Structural Equation Modeling

Structural Equation Modeling is utilized in this study for testing the research hypotheses. In order to reinforce the stability of goodness of fit, the average of highest and lowest factor loadings is used for grouping and parcleing the measurement questions of new market and competitor market targeted disruptive innovation, and the mean of the group scores is regarded as the measurement index of outbound disruptive innovation; 4 measurement questions are included. Chang et al. (2003) stated that such a method presented

satisfactory statistical characteristics. Using AMOS20.0 as the analysis tool and applying Maximum Likelihood to the preliminary estimation, the goodness of fit shows the chi-square ($\chi 2$)-degree of freedom (DF) ratio ($\chi 2/DF=$) 1.981, lower than 3, RMSE 0.076, lower than 0.08, and GFI and CFI 0.887 and 0.896, slightly "higher than 0.9". Simply revising the model, GFI and CFI achieve the ideal area 0.9, presenting the favorable goodness of fit of the revised model, better than the goodness of fit of sample data. The path coefficient could reasonably and effectively reflect the causal relationship between variables that it could be used for testing the hypotheses proposed in this study. The resutls are shown in Figure 2.

Table 1 - Descriptive Statistics and Correlation Analysis
(made by co-authors)

	M	SD.	1	2	3	4	5	6	7
1. Age of enterprise	3.000	.8694	1						
2. Size of enterprise	2.890	.7958	.462**	1					
3. Nature of enterprise	.179	.3846	.226**	.160*	1				
4. Combination-embeddedness	4.757	.9468	.065	.188*	-.008	1			
5. Major business specificity	5.755	.6165	.111	.068	-.064	.188*	1		
6. Outbound disruptive innovation	5.116	.9128	.030	.036	-.029	.182*	.265**	1	
7. Inbound disruptive innovation	4.121	1.1653	-.117	-.230**	-.122	-.064	-.328**	.224**	1

n=173; *p<.05, **p<.01

From Fig. 2, the standardized path coefficient between combination-embeddedness and major business specificity of knowledge assets appears 0.199, and P<0.05 and achieves the significance, showing the directly positive effect of combination-embeddedness existing knowledge assets on major business specificity of enterprises (H1 is supported). The standardized path coefficient between combination-embeddedness of knowledge assets and outbound disruptive innovation reveals 0.187, and P<0.05 reaches the significance, presenting the directly positive effect of existing knowledge assets combination-embeddedness on outbound disruptive innovation of enterprises (H2 is supported). The standardized path coefficient between combination-embeddedness of knowledge assets and inbound disruptive innovation appears 0.058, not passing the significant test (H3 is not supported). The standardized path coefficient between major business specificity of knowledge assets and outbound disruptive innovation is 0.233, and P<0.05 reaches the significance, revealing the directly positive effect of major business specificity of existing knowledge assets on outbound disruptive innovation of enterprises (H4 is supported). The standardized path coefficient between major business specificity of knowledge assets and

inbound disruptive innovation reveals -0.413, and P<0.05 achieves the significance, showing the directly negative effect of major business specificity of existing knowledge assets on inbound disruptive innovation of enterprises (H5 is supported).

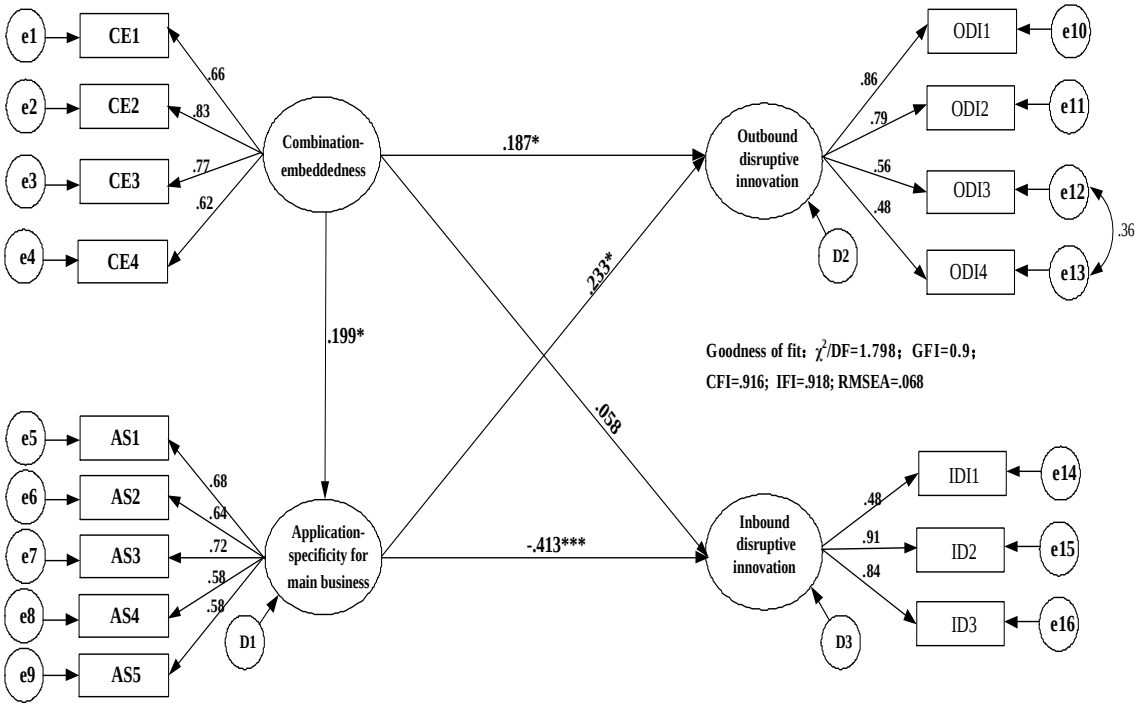


Figure 2 - Path fit diagram
(made by co-authors)

Structural Equation Modeling is utilized for analyzing the mediation effect of major business specificity. Compared with traditional mediation effects based on the test with Multiple Regression Analysis, Structural Equation Modeling allows all variables being tested at the same time, the goodness of fit of the model could be evaluated, and I-type errors could be reduced. As afore mentioned, combination-embeddedness presents notably positive effects on major business specificity (with the standardized path coefficient 0.199*), and major business specificity also appears significant effects on outbound and inbound disruptive innovation (with the standardized path coefficients 0.233* and -0.413***). It explains the remarkable mediation effect of major business specificity on the effects of combination-embeddedness on outbound and inbound disruptive innovation of enterprises (with the mediation effect 0.046 and -0.082, respectively). Meanwhiule, combination-embeddedness shows directly positive effects on outbound disruptive innovation, but the directly negative effect on bound disruptive innovation is not notable that major business specificity appears partially mediation effects on the relationship between combination-embeddedness and outbound disruptive innovation, but full mediation effects on the relationship between combination-embeddedness and inbound disruptive innovation.

Conclusion and Inspiration

The effects of the attribute and result of knowledge assets on disruptive innovation are regarded as the research topic in this study. Based on literature review and theories, combination-embeddedness of knowledge assets is the independent variable, major business specificity is the mediator, and outbound and inbound disruptive innovation is the dependent variable. Based on knowledge attributes, Structural Equation Modeling for the effect of knowledge assets of enterprises on disruptive innovation is constructed, and 173 valid copies of questionnaire on manufacturing enterprises in China are proceeded empirical analyses to present the relatioship between combination-embeddedness and major business specificity of existing knowledge assets of an enterprise and the effects on disruptive innovation.

Result discussion

First, combination-embeddedness of knowledge assets presents significantly positive effects on major business specificity of enterprises, showing the higher complicated network formed by the interaction among employees, instrument, and practice, in which enterprises knowledge embeds, the stronger stickness to the major business, and the use area and the economic value would focus more on the major business. Such a conclusion offers a new thinking for the research of Mcevily et al. (2003) and Reagans & Mcevily (2003) on successful knowledge transfer between organizations. Major business specificity of knowledge assets might be the restraint on successful knowledge transfer between organizations, while combination-embeddedness of knowledge assets might reinforce major business specificity to further restrain the successful knowledge transfer between organizations.

Second, major business specificity of knowledge assets appears opposite functions on outbound and inbound disruptive innovation of enterprises. Major business specificity of knowledge assets shows remarkably and directly positive effects on outbound disruptive innovation of an enterprise, but notably and directly negative effects on inbound disruptive innovation. It reveals that an enterprise with higher major business specificity o knowledge assets could allocate more resources to the major business. It, on one hand, digs out the value space related to existing knowledge assets of the major business and develops more external market targeted disruptive product innovation activities, and on the other hand promotes the developemnt of current knowledge assets around the major business to reinforce the innovation activities sticking to current knowledge, which is adverse to internal market targeted disruptive innovation. The research conclusion provides a possible explanation for understanding the viewpoints of Christensen (1997), Assink (2006), and Lindsay and Hopkins (2010) about the relationship between knowledge assets and disruptive innovation. It is not the simply positive or negative relationship between them, major business specificity

of knowledge assets and the cognition of disruptive innovation of an enterprise should be taken into account.

Third, combination-embeddedness of knowledge assets shows opposite functions on outbound and inbound disruptive innovation of enterprises. Combination-embeddedness of knowledge assets apepars remarkably positive effects on the development of outbound disruptive innovation of an enterprise, including the directly positive effect and the indirectly positive mediation effect of major business specificity. Combination-embeddedness presents remarkably negative effects on inbound disruptive innovation, and such negative effects are indirect, with the mediation effect of major business specificity. It shows that an enterprise with higher combination-embeddedness of knowledge assets could better control the composition and application of such knowledge assets. On one hand, it could enhance enterprises, based on the use experiences and model of major business, constantly trying such knowledge assets in different business fields for disruptive application. On the other hand, it reinforces the dependence of enterprises on such knowledge assets and the major business, but could have them reject new items and new knowledge which might replace existing products or damaging the major business. The research conclusion, based on the aspect of knowledge assets, expands the research coverage on disruptive innovation and suppliments the discussions of Christensen (1997), Assink (2006), and Lindsay and Hopkins (2010) about the relationship between knowledge assets and disruptive innovation. Instead of classifying existing knowledge assets of an enterprise, according to the content and specific form, it is better analyzing knowledge asset attributes which could possibly affect disruptive innovation. Combination-embeddedness and major business specificity are two critical features attribute of existing knowledge assets influencing disruptive innovation of an enterprise.

Management inspiration

The research conclusion presents significant inspiration on enterprises practicing knowledge assets management and innovation management. First, existing knowledge assets are the bases of innovation development, but there is not an “apparent” positive relationship between them; the match between knowledge asset attributes and various types of innovation needs to be considered. For disruptive innovation, enterprises could promote outbound disruptive innovation with combination-embeddedness and major business specificity which show higher knowledge assets. Second, from the aspect of knowledge assets management, enterprises should establish knowledge asset evalaution systems or knowledge search practice (Garud & Nayyar, 1994) to dynamically track and evaluate combination-embeddedness and major business specificity of existing knowledge assets, to classify such knowledge assets, based on above two dimensions, and to guide them developing correspondent disruptive innovation with such information. On one hand, major business specificity of knowledge assets are utilized for promoting existing knowledge assets in the disruptive application to different business fields. On the other hand, the innovative

knowledge assets management constantly accumulates low major business specificity of knowledge assets to offer novel knowledge for enterprises developing inbound disruptive innovation.

Reference

Allarakhia, M. & Walsh, S. (2011). Managing knowledge assets under conditions of radical change: the case of the pharmaceutical industry. *Technovation*, 31(2): 105-117.

Anderson, N., Potochnik, K. & Zhou, J. (2014). Innovation and creativity in organizations a state-of-the-science review, prospective commentary, and guiding framework. *Journal of Management*, 40(5): 1297-1333.

Argote, L. & Ingram, P. (2000). Knowledge transfer: a basis for competitive advantage in firms. *Organizational Behavior & Human Decision Processes*, 82(1): 150-169.

Assink, M. (2006). Inhibitors of disruptive innovation capability: a conceptual model. *European Journal of Innovation Management*, 9(2): 215-233.

Battistella, C., De Toni, A. & Pillon, R. (2015). Inter-organisational technology/ knowledge transfer: a framework from critical literature review. *The Journal of Technology Transfer*, 1-40.

Birkinshaw, J., Nobel, R. & Ridderstråle, J. (2002). Knowledge as a contingency variable: do the characteristics of knowledge predict organization structure? *Organization Science*, 13(3): 274-289.

Cable, D. M. & DeRue, D. S. (2002). The convergent and discriminant validity of subjective fit perceptions. *Journal of Applied Psychology*, 87(5): 875-884.

Chang, L., McBride-Chang, C. & Stewart, S. M. (2003). Life satisfaction, self-concept, and family relations in Chinese adolescents and children. *International Journal of Behavioral Development*, 27(2):182-190.

Chang, L., Schwartz, D., Dodge, K. & McBride-Chang, C. (2003). Harsh parenting inrelation to childe motion regulation and aggression. *Journal of Family Psychology*, 17: 598-606.

Chang, S., Gong, Y., Way, S., & Jia, L. (2013). Flexibility-oriented HRM systems, absorptive capacity, and market responsiveness and firm innovativeness. *Journal of Management*, 39(7): 1924-1951.

Christensen, C. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston: Harvard Business School Press.

Christensen, C. (2006). The Ongoing Process of Building a Theory of Disruption. *Journal of Product Innovation Management*, 2006(23): 39-55.

Christensen, C. & Raynor, M. (2003). *The Innovator's Solution: Creating and Sustaining Successful Growth*. Boston: Harvard Business School Press.

Cohen, W. & Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35: 128-152.

Corsi, S. & Di Minin, A. (2014). Disruptive innovation… in reverse: Adding a geographical dimension to disruptive innovation theory. *Creativity and Innovation Management*, 23(1): 76-90.

Cummings, J. (2002). *Knowledge transfer across R&D units: an empirical investigation of the factors affecting successful knowledge transfer across intra-and inter-organizational units*. UMI.

Cummings, J. & Teng, B. (2003). Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering & Technology Management*, 20(s 1-2): 39-68.

Danneels, E. (2004). Disruptive technology reconsidered: A critique and research agenda. *Journal of product innovation management*, 21(4): 246-258.

Davenport, T. (2008). Enterprise 2.0: The New, New Knowledge Management? *Harvard Business Online*, Feb. 19.

Davis, P. (1998). *Path-Dependence: Putting the Past into the Future of Economics*. Working Paper: Department of Economics, Stanford University.

Di Guardo, M. & Harrigan, K. (2015). Shaping the path to inventive activity: The role of past experience in R&D alliances. *The Journal of Technology Transfer*, 1-20.

Edvinsson, L. & Sullivan, P. (1996). Developing a model for managing intellectual capital. *European management journal*, 14(4): 356-364.

Fitzroy, F. & Mueller, D. (1984). Cooperation and Conflict in Contractual Organization. *Quarterly Review of Economics and Business*, 24(4): 23-49.

Garud, R. & Nayyar, P. (1994). Transformative capacity: Continual structuring by intertemporal technology transfer. *Strategic Management Journal*, 15: 365-385.

Gilbert, C. & Bower, J. (2002). Disruptive change. When trying harder is part of the problem. *Harvard Business Review*, 80(5): 94-101.

Hang, C., Garnsey, E., & Ruan, Y. (2015). Opportunities for disruption. *Technovation*, 39: 83-93.

Hung, K., & Chou, C. (2013). The impact of open innovation on firm performance: The moderating effects of internal R&D and environmental turbulence. *Technovation*, 33(10): 368-380.

Kostopoulos, K., Papalexandris, A., Papachroni, M. & Ioannou, G. (2011). Absorptive capacity, innovation, and financial performance. *Journal of Business Research*, 64(12): 1335-1343.

Levinthal, D. & March, J. (1993). The Myopia of Learning. *Strategic Management Journal*, (14): 95-112.

Lichtenthaler, U. (2009). Absorptive capacity, environmental turbulence, and the complementarities of organizational learning processes. *Academy of Management Journal*, 52: 822-846.

Lin, C., Zhang, Z. & Yu, P. (2015). Measurement and empirical research on low-end and new market disruptive innovation. *Journal of Interdisciplinary Mathematics*, 18(6): 827-839.

Lin, C., Zhang, Z., Li, Y. B. & Wu, T. (2015). Effects of absorptive capacity on incremental and radical innovation based on organisational learning processes. *Oxidation Communications*, 38(2A): 1105-1120.

Lindsay, J. & Hopkins, M. (2010). From experience: Disruptive Innovation and the Need for Disruptive Intellectual Asset Strategy. *Journal of Product Innovation Management*, 27(2): 283-290.

Mcevily, B., Argote, L. & Reagans, R. (2003). Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes. *Management Science*, 49(4): 571-582.

Nonaka, I. (1988). Toward Middle-Up-Down Management: Accelerating Information Creation. MITSloan managemet review, 29(3): 9-18.

Palacios Fenech, J. & Tellis, G. (2016). The Dive and Disruption of Successful Current Products: Measures, Global Patterns, and Predictive Model. *Journal of Product Innovation Management*, 33(1): 53-68.

Ratinho, T., Harms, R. & Walsh, S. (2015). Structuring the Technology Entrepreneurship publication landscape: Making sense out of chaos. *Technological forecasting and social change*, 100: 168-175.

Reagans, R. & Mcevily, B. (2003). Network Structure and Knowledge Transfer: The Effects of Cohesion and Range. *Administrative Science Quarterly*, 48(2): 240-267.

Teece, D. (2000). Strategies for managing knowledge assets the role of firm structure and industrial context. *Long Range Planning*, 33: 35-44.

Tsai, W. (2001). Knowledge Transfer in Intra-organizational Networks: Effects of Network Position and Absorptive Capacity on business unit innovation and performance. *The Academy of Management Journal*, 2001(44): 996-1004.

Un, C. & Asakawa, K. (2015). Types of R&D collaborations and process innovation: The benefit of collaborating upstream in the knowledge chain. *Journal of Product Innovation Management*, 32(1): 138-153.

Wan, F., Williamson, P. & Yin, E. (2015). Antecedents and implications of disruptive innovation: Evidence from China. *Technovation*, 39: 94-104.

Wang, Y., Vanhaverbeke, W., & Roijakkers, N. (2012). Exploring the impact of open innovation on national systems of innovation—A theoretical analysis. *Technological Forecasting and Social Change*, 79(3): 419-428.

Williamson, O. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications: A Study in the Economics of Internal Organization*. Social Science Electronic Publishing.

Williamson, O. E. (1985). *The Economic Institutions of Capitalism*. New York-London: The Free Press.

Wu, F. & Haak, R. (2013). Innovation mechanisms and knowledge communities for corporate central R&D. *Creativity and Innovation Management*, 22(1): 37-52.

Zahra, S. & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, 27: 185-203

Paper submitted on 07 September 2016